ORIGIN AND MANAGEMENT
OF
PCB WASTE

April, 1984

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Ministry
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Environment

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The Honourable
Andrew S. Brandt
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HAZARDOUS CONTAMINANTS
AND STANDARDS BRANCH
135 ST. CLAIR AVENUE WEST
TORONTO, ONTARIO M4V 1P5

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ABSTRACT

The first part of this document is a revised guideline for the handling and disposal of PCBs in Ontario, and replaces an earlier document, Pollution Prevention and Waste Management Guidelines for Polychlorinated Biphenyls, (November 1978).

The guideline applies to all materials containing, or contaminated by, polychlorinated biphenyls (PCBs). A regulatory control level of 50 ppm is used to segregate materials contaminated with PCB into two distinct categories.

Material contaminated with or containing over 50 ppm PCBs, which comprises the bulk of PCBs presently in Ontario, is to be controlled within the framework of O. Reg. 11/82 until such time as a storage or destruction facility is approved in Ontario.

Recognizing the lower hazard posed by materials contaminated with or containing 50 ppm PCBs or less, several acceptable avenues for the safe and controlled disposal of such materials have been provided.

The second part of the document is a background document to the PCB problem. An attempt has been made to throw various aspects of the PCB problem into perspective and to review briefly some of the existing disposal technologies.

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APPENDICES

(A) PCB Waste Management Regulation (O.Reg. 11/82)

(B) Federal Chlorobiphenyl Regulations

(C) Boiler Criteria for Co-combustion of Liquids Containing 50 ppm PCB or Less

(D) Handbook on PCBs in Electrical Equipment

MANAGEMENT OF MATERIALS CONTAMINATED WITH PCB

INTRODUCTION

Because of their persistence and tendency to biomagnify in fatty tissue, the escape of polychlorinated biphenyls (PCBs) into the environment in general, and into the aquatic environment in particular, constitutes a potential threat to both humankind and other species. It is therefore essential that those PCBs which are either still in use or are being retained in storage for future disposal be controlled and disposed of in ways which will minimize adverse environmental effects. The purpose of these guidelines is to clearly define the main classes of materials contaminated with PCBs, and to lay out the acceptable management options currently available for their safe storage, handling or disposal.

RATIONALE

The intent of these guidelines is to protect human health and the environment from further PCB contamination as a result of the improper handling and disposal of materials contaminated with PCB. Implementation of measures to ensure the proper handling and disposal of PCBs, however, faces a logical dilemma. On the one hand there is a need to establish a minimum control concentration that will both ensure effective regulation of as much PCB as possible and still be administratively feasible. On the other hand there is no available information which would scientifically substantiate selection of any one particular regulatory cut-off level over another as ensuring protection of human health or the environment.

The process of selecting a regulatory cut-off level for PCB was first faced by the U.S. Environmental Protection Agency (29). In 1979 an optimal cut-off level of 50 ppm was adopted as a culmination of an extensive cost-benefit analysis of various control levels. Environment Canada has examined the U.S. evidence, and, deeming it acceptable, has decided that there was no necesssity to repeat the exercise in Canada. The 50 ppm level has therefore been selected for the Canadian Product and Release Regulations (Appendix B), and this choice, besides having the advantage of international compatability, has also been supported by Health and Welfare Canada after a review of health effects data generated since the deliberations of the original federal Task Force on PCBs (5).

In drafting these guidelines and the PCB Waste Management Regulation (Appendix A), the Ministry of the Environment has also adopted the 50 ppm concentration as a starting point for drawing up acceptable handling and disposal options for PCB materials. Any material containing in excess of 50 ppm PCB is classified as a "designated PCB waste", and any material containing 50 ppm or less PCB is not a designated PCB waste. Materials falling in the first category are stringently regulated and will require special handling and disposal. Materials falling in the second category possess an environmental problem potential of a significantly lower order, and a wider range of handling and disposal options will be offered for materials falling in this category.

MATERIAL DISTRIBUTION

Transformers and capacitors containing askarel (40-70% PCBs in a solvent such as trichlorobenzene) constitute the largest source of PCBs in Ontario. The majority of equipment containing askarel is still in service, and the most recent Environment Canada inventory shows approximately 7500 tonnes of askarels distributed across the Province.

The second largest source of PCBs is low-level concentrations which have inadvertently contaminated the mineral oil in many non-askarel transformers. Because individual units have, in general, not been tested for PCB content, it is difficult to determine the exact amount of PCB involved. However, a statistical sampling by Ontario Hydro indicates that 95% of their mineral oil contains less than 50 ppm PCB. Using this and available U.S. data on the ratio of askarel to mineral oil (24, 28), the following data on amounts of PCB material in Ontario have been derived:

	Total liquid volume (tonnes)	PCB Content (tonnes)
Askarel units	9,500	6,700
Mineral oil units	528,200 (est)	8

In addition, there is a wide range of PCB-contaminated solids in storage. Protective clothing, tools and soil from spills constitute the bulk of this material. The level of PCBs in these materials is generally low, i.e. less than 50 ppm, and the total tonnage of material involved not large when compared with the total tonnage of PCB-contaminated liquids.

PCB USAGE AND REGULATION

The usages to which PCBs may still be legally put in Canada are controlled by the federal Environmental Contaminants Act and regulations made under that Act (see Appendix B):

- Chlorobiphenyl Regulation #1 (as amended)
- Chlorobiphenyl Regulation #2 (Product)*
- Chlorobiphenyl Regulation #3 (Release)*

* Notice of Intent gazetted January 21, 1984.

The disposal of PCB-contaminated liquids and solids falls under provincial jurisdiction, and is subject to the following legislation:

- Environmental Protection Act
- Ontario Water Resources Act
- Dangerous Goods Transportation Act, 1981
- Environmental Assessment Act
- Transfers of Liquid Industrial Waste (Reg. 313)
- PCB Waste Management Regulation (O.Reg. 11/82)

DESIGNATED PCB WASTES

Waste materials containing over fifty parts per million (50 ppm w/w) PCB are now designated wastes as defined in Part V of the Environmental Protection Act. Under the provisions of O.Reg. 11/82 (Appendix A), the owners of designated PCB wastes are required to store them on their own property in an approved manner, i.e. consistent with the federal guidelines for the management of PCB wastes (Appendix D), until such time as there

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i) On receipt of Director's Instructions issued under the provisions of O.Reg. 11/82, the owner of designated PCB wastes may consign such wastes to the holder of a waste management system certificate of approval issued after January 1, 1981, containing terms specifying the manner in which the PCB wastes may be stored, handled, treated, collected, transported, processed or disposed of;

ii) On receipt of Director's Instructions issued under the provisions of O.Reg. 11/82, the owner of such PCB wastes may treat them in an approved manner in order to render them non-designated materials. For example, PCB concentrations in aqueous mixtures or emulsions may be decreased with activated carbon to a level where the liquid may then be safely disposed of in a manner consistent with these guidelines. Several patented processes are also available for substantially reducing the PCB concentration in contaminated mineral oil; the treated liquid may then either be reused or disposed of in a manner consistent with these guidelines; and

iii) Subject to the boiler having been approved for such use by the Ministry of the Environment's Approvals and Project Engineering Branch under the appropriate provisions of the Environmental Protection Act, PCB liquid containing more than

50 ppm and less than 500 ppm PCB may be disposed of by coincineration. Depending on the circumstances, Director's Instructions may be required.

LIQUIDS CONTAMINATED WITH 50 PPM PCB OR LESS

(a) Organically-based liquids

There are several acceptable avenues for the disposal of PCB solutions or mixtures containing 50 or less ppm PCBs:

i) Supplementary fuel in industrial boilers. Units similar to those specified in (3)(iii) above, but of a lower rating, would be eligible (See Appendix C);

ii) Re-refining or recycling feedstock;

iii) Dust suppressant on coal piles at large thermal generating stations or steel mills;

iv) Dust suppressant on unpaved rural roads. In accordance with federal regulation (Appendix B), the maximum PCB content of any road dust suppressant shall not exceed 5 ppm.

(b) Aqueous liquids

The solubility of PCBs in pure water is very low (10-50 ppb); batches of oil-water emulsions may, however, occasionally be found with considerably higher PCB concentrations (50-100 ppm). Such concentrations may be lowered by treating the liquid with activated carbon, or other appropriate materials.

Since it has been demonstrated that PCBs in water at low concentrations are readily adsorbed on soil particles (7, 8), and provided the PCB concentration in the treated liquid phase is less than five parts per million (5 ppm), this liquid may be safely disposed of by spraying it on soil in a manner similar to that used for dust suppression on unpaved roads (1.0-1.5 L/m^2). If the PCB concentration is less than five parts per billion (5 ppb), an alternative is to add the liquid to the influent of a sewage treatment plant by prior arrangement with the operating authority at a rate to be determined by the latter. This rate shall be such that, assuming there is no other avenue of treatment except dilution, the concentration of PCB in the plant effluent shall not impair the Ministry's water management objective for receiving bodies, i.e. 1 ppt, after mixing. In instances such as this the bulk of the PCB will actually end up in the sewage sludge.

The above disposal methods are not intended for routine or frequent usage, and should only be used for batchwise disposal on a case-by-case basis.

PCB CONTAMINATED CONTAINERS

After draining or emptying completely, any package, can, bottle, bag, barrel, drum, tank or other device (except a transformer) which has contained either PCB liquids or PCB-contaminated solids may be decontaminated by rinsing it internally at least three times with an acceptable organic solvent, and using a solvent volume for each rinse equal to at least 10% of the container volume. Care must be taken to ensure that the entire inner surface of the container is contacted by the rinse fluid. Between rinses and after the final rinse, the container must be thoroughly drained.

Decontaminated items should not be reused for any purpose other than holding PCBs and may be disposed of in an approved landfill after puncturing and crushing. Solvent may be reused for rinsing provided it still contains less than 50 ppm PCBs. Used solvent shall be disposed of in a manner consistent with these guidelines .

From the point of view of disposal of the rinsings, acceptable solvents include No. 1 or 2 fuel oils, kerosene or mineral oil. Where solvent flammability is a problem, ethylene glycol may be used.

PCB-CONTAMINATED SOLIDS

Because of their varied nature and degree of contamination, PCB-contaminated solids do not lend themselves to a single avenue for disposal. However, solid materials contaminated with less than 50 ppm PCBs generally will not require special treatment or disposal, and can be managed in accordance with the requirements of these guidelines.

(a) Transformers

Because the residual PCB in the core leaches out into the substitute dielectric fluid, retrofill of askarel transformers is as yet generally not economical. There may, however, be some isolated cases where constraints other than economics control. The repeated replacement of dielectric fluid required as a means of achieving a final PCB liquid concentration less than 50 ppm might then be justified.

The majority of PCB-contaminated mineral oil transformers can be effectively retrofilled after completely draining the original contaminated mineral oil from the casing. Triple rinsing (see below) might be required if the original PCB concentration were excessive, i.e., over 1000 ppm.

Askarel transformers may be decontaminated with a view to either scrap metal recovery or landfill disposal. The decontamination process consists of a sequence of draining and triple rinsing with an appropriate solvent. The original fluid must first be drained effectively, i.e., all pools of PCB in the casing must be removed. For each rinse with a solvent such as trichlorobenzene, kerosine, xylene or toluol, the unit must be completely filled with solvent. This will require venting to atmosphere from the highest point on the casing to ensure that the unit actually is full. For each rinse the filled transformer must sit for at least eighteen hours to allow the solvent to penetrate the core, and the unit must be properly drained between rinses. Contaminated solvent shall be disposed of in a manner consistent with these guidelines.

(b) Capacitors

According to their liquid PCB content, capacitors are classified as "large" or "small". The latter contain a maximum of one kilogram (approx. 0.75 L) of pure PCB (equivalent to 1 L askarel). It should be borne in mind that this is a ceiling level, and that most small capacitors contain much less. Capacitors used in lighting and air conditioning may contain as little as 0.002 L.

Individual small PCB capacitors for disposal may be treated as municipal solid waste destined for landfill. However, large capacitors and accumulated quantities of small capacitors shall be considered as designated wastes, and managed accordingly until such time as an acceptable disposal process for such items is available.

(c) Large equipment items

Items such as hydraulic systems, heat transfer systems and vapour diffusion pumps may be decontaminated by a procedure similar to that in (a) above and approved under a Director's Instruction issued under the provisions of O.Reg. 11/82. The decontaminated equipment may then be retrofilled with a substitute fluid, salvaged for scrap or disposed of in a municipal landfill.

(d) Soil

Soil may become contaminated with PCBs either as a result of a spill or a leakage. Because the risk of ground- or surface-water contamination may vary widely, each incident should be treated on a case-specific basis.

The principal factors to be considered are:

- The total amount and concentration of PCB liquid involved;
- The potential for surface- or ground-water contamination;
- The use to which the water is put, including consideration of aquatic communities.

Where local groundwater is a source of potable water and is also overlain by highly percolative soils, it will be necessary to remove contaminated soil to a much lower residual PCB concentration than in cases where neither of these pertain. Under certain conditions, however, it may be deemed preferable not to disturb contaminated soil.

All contaminated soil containing over 50 ppm PCBs (w/w) is a designated waste, and must be stored in accordance with the provisions of O.Reg. 11/82 until such time as an acceptable method of disposal is developed.

Since PCBs in low concentration are effectively absorbed on soil particles, contaminated soil containing less than 50 ppm PCBs may be disposed of in an approved landfill on a case-by-case basis. The material should not be drummed at time of disposal, but well distributed throughout the working area of the landfill to ensure the maximum rate of PCB degradation. The volume of soil involved should be related to the degree of contamination. In round figures, 100 barrels of moist soil contaminated with 50 ppm PCB will contain approximately one kilogram of PCB -- the equivalent of one "small" capacitor (7,8).

TRANSPORTATION OF PCBs

The transportation of hazardous materials, among which may be numbered PCB-contaminated liquids and solids, is controlled interprovincially and internationally under federal legislation and intra-provincially by provincial legislation. Regulations made under the respective Acts are presently under development. Until such time as these become effective, the following general concepts should be adhered to.

Designated PCB wastes shall be transported in labelled heavy-duty (No. 16 gauge min.) steel drums free from defects. All drums shall be palletized and strapped, both to the pallet and to each other. Extreme care should be taken to ensure that a shipment is not exposed to rough handling or to tampering by unauthorized persons. Transformers, full or empty, shall be shipped in a similar manner to drums. However, they shall also be wrapped in heavy-duty polyethylene sheeting (6 mil. min.).

Provincial waybills are required and shall accompany all shipments of PCB waste, liquid or solid. Accordingly, the transporter of these wastes must be the holder of a valid Ministry of the Environment Waste Management System Certificate. All shipments must be appropriately packaged, and, where required, the transporting vehicle shall also be placarded (6).

POLYCHLORINATED BIPHENYLS

INTRODUCTION

This section covers the background to the current problem of how to manage and dispose of polychlorinated biphenyls (PCBs). It shows that an ample body of legislation and technology already exists to handle and destroy the substantial volume of PCBs still in Ontario in an environmentally-acceptable manner. The missing links in the disposal chain are public acceptance of technology and a statement of policy on how various types of materials contaminated with PCB should be handled. The latter issue has been addressed in the section on PCB waste management, which forms the main portion of this report. It must, however, be realized that current options are severely limited by the non-availability of either approved centralized storage or destruction facilities.

Environmental problems arising from the increased use of chlorinated hydrocarbons since 1940 have begun to manifest themselves on a world-wide scale in the last twenty years. Chlorinated hydrocarbons, by virtue of their chlorine content, are very resistant to natural degradation processes, i.e. they are persistent. Because of this persistence, chlorinated hydro carbons tend to pass unchanged to successively higher levels in the food chain, and to accumulate in the fatty tissues of all living organisms. They become concentrated, or undergo biomagnification, at each successive trophic level. Humans stand at the top of the food chain, and PCBs have been demonstrated to be present in human tissue. They have also evoked adverse health related responses in lower species. On the basis of these facts, it is therefore imperative that a safe and efficient management program be adopted to minimize any adverse impact arising from the use and disposal of PCBs.

BACKGROUND

PCBs are organic compounds composed of carbon, hydrogen and chlorine atoms, and they are formed by the progressive substitution of chlorine atoms for the hydrogen atoms of the basic biphenyl molecule. Theoretically this would give rise to over 200 possible biphenyl compounds; however, only 84 have been identified. As commercially prepared, mixtures of various isomers were obtained by chlorination of biphenyl, and these mixtures were then partially separated by distillation into fractions of different molecular weight range.

Most of the PCBs sold in North America were marketed under the trade name of Arochlor. This was followed by a four-digit number specifying the particular fraction, e.g. Arochlor 1254: the 12 indicated that the material was a chlorinated biphenyl (as opposed to any other chlorinated aromatic hydrocarbon) and that the average weight percent of chlorine in the mixture was 54 percent. Eight different Arochlors were available with chlorine contents ranging from 21 to 68 percent. Other PCB brand names included Hyvol, Inerteen and Pyranol. When used in electrical equipment, their primary application, PCBs were blended with other chemicals, such as trichlorobenzene, and the resultant mixture was known generically as "askarel" in North America.

Although they were first synthesized in the 1880's, PCBs were not manufactured commercially until 1929. At that time, a drastic reduction of manufacturing costs coupled with an array of desirable physical and chemical properties inherent in all the isomers to one degree or another suggested a number of commercial applications for PCBs.

PCBs were found to have:

- low vapour pressures;
- low water solubility;
- high solubility in fats and oils;
- high dielectric constants;
- low flammability;
- excellent thermal, chemical and biological stability;

and these properties are desirable in:

- dielectric fluids in large electrical transformers and capacitors;
- hydraulic fluids;
- waterproofing agents;
- plasticizers.

Other uses for PCBs were in the preparation of some types of:

- varnishes
- textile coatings;
- carbonless copying paper;
- flame retardants;
- paints;

- printing inks;
- petroleum additives;
- adhesives.

PCBs proved to be so satisfactory in many applications that world production had risen by 1970 to 200,000 tonnes annually. By this time the environmental impact of PCBs began to be realized, and moves on an international scale were made, first to restrict the uses to which PCB were put and later to ban its use altogether. Currently, Ontario, as many other jurisdictions, is focusing on efforts to control those PCBs still in service and to dispose of PCB wastes as they are produced in a environmentally-accepted manner.

No PCBs are, however, known to have been manufactured in Canada, and the major importer, Monsanto Canada, discontinued sales for use in other than closed systems, e.g. transformers, in 1971. Manufacture of PCBs in North America ceased altogether in 1977. It is estimated that some 31,000 tonnes were imported into Canada over a 50 year period, and the federal inventory as of August 1979 had accounted for some 16,300 tonnes. Most of the inventoried material is located in Ontario (55.6%), nearly all of this is currently in use (92.9%), and the bulk of the material still in use is in electrical equipment such as transformers and capacitors (99.5%).

It is ironic that some of those very physical and chemical properties which had made PCBs so attractive commercially were to be the same characteristics which were to make it so undesirable environmentally --their chemical and biological stability, and their solubility in lipids and organic solvents. Both the chronic and acute toxicity of PCBs to workers handling them were recognized early on, and exposure arising from inhalation or skin contact in industrial plants where PCBs were manufactured or used was appropriately regulated; however, no reason for concern was felt about their effects outside the context of industrial hygiene. This may be attributed partly to a general unawareness of environmental interrelationships and the relatively unsophisticated analytical techniques then available to determine trace contaminant levels.

During the immediate postwar period, however, more and more sophisticated detection and analytical techniques and equipment were developed. These were used to address the concerns aroused by the use of persistent chlorinated pesticides, such as DDT. In the course of two investigations in 1966-7 in Sweden and Great Britain traces of an unknown substance which interfered with pesticide analyses were detected in tissues of birds, fish and mammals. These traces were soon identified as PCBs. Further world-wide investigations revealed that PCBs were present in both living and non-living system from the Equator to the poles. Levels as high as 3000 ppm were found in Hudson River sediment; 900 ppm were reported in the liver of a British heron; North Atlantic plankton contained 0.3 ppm; and levels of 10 ppt were measured in air and seawater.

While it was relatively easy to demonstrate how persistent pesticides such as DDT could be ingested by animals and other organisms, there was no obvious pathway to suggest how PCBs could gain such widespread distribution except as a result of careless practices in the manufacture, use and disposal of PCBs at a time when the environmental consequences of such actions were not fully appreciated. PCBs do not occur naturally, and there are, therefore, few natural organisms, such as bacteria, capable of metabolizing them. When this was coupled with their inherent low chemical reactivity, it was almost inevitable that PCBs released into the major components of the ecosphere and not otherwise stabilized would eventually find their way into the biosphere, or living systems, i.e. become biologically available. Through various routes such as low-temperature incineration, accidental spills, intentional dumping, leaching from landfills, PCBs have been introduced into the ecosphere, and some of this material will undoubtedly be assimilated by various life-forms. The accumulation in the simpler life-forms at the bottom of the food chain can lead to the accumulation of PCBs in higher animals, such as man. Due to their fat-soluble nature, PCBs may be translocated through the food chain, accumulating as a residue in fatty tissue because of living organisms' poor ability to metabolize them. Undergoing biomagnification from one link, or trophic level, in the chain to the next, PCBs may reach potentially toxic levels at the top of the chain. It should be realized, however, that the relationship between trophic levels and biomagnification is neither clear-cut nor well understood, particularly in the aquatic environment.

The toxicology of PCBs, both acute and chronic, is complicated by the fact that, as manufactured, formulations may be contaminated by very low concentrations of other toxic compounds of related molecular structure, such as polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF), and that after an extended period of use, various other degradation products, and metabolites may also be present. As deduced from animal studies, the acute oral toxicity of PCBs is low, being of the same order as DDT, and, as mentioned earlier, workers who absorb too much through inhalation or skin contact are liable to develop skin lesions. The chronic toxicity of PCBs is, however, less well understood.

Except for one documented study of suspected PCB poisoning in Japan, investigations have been limited to work on laboratory animals, and the following are some of the effects observed: increased liver weight, reproductive failures, thyroid abnormalities, growth retardation and some neoplastic activity. The first four effects are believed to be related to interferences in hormonal functions, and the last indicates a possibility that PCBs may be potential carcinogens in humans. It should, however, be emphasized that the latter possibility is speculative and has never been confirmed. While all PCB mixtures tested have shown carcinogenic activity in animals, the lowest dietary level causing tumors was 10 ppm(26). Work in the United Kingdom indicated that in the great majority of foodstuffs the prevailing levels were well below 0.05 ppm(23).

PCB USES AND PCB WASTES

While some individual isomers of PCBs are solids at room temperature, the commercial mixtures sold were all liquid. These oily liquids, which vary in colour from crystal clear to pale yellow and have a density greater than water, were used in both dispersed and non-dispersed applications.

In their dispersed applications PCBs were incorporated into a wide range of liquids and solids, e.g. sealants, hydraulic fluids, paints, plasticizers, carbonless carbon paper and specialty printing ink, until 1972. At that time the Monsanto Corporation, the sole North American manufacturer of PCBs, voluntarily ceased marketing PCBs for such applications. It is believed that the release of PCB's arising during the life and subsequent disposal of these materials, through the avenues of incineration, landfilling or flushing into drains or sewers discharging ultimately into watercourses, is the principal source of the world-wide dispersion of PCBs uncovered during the early 1970's. Because such materials containing PCBs will continue to be taken out of service for some years to come, it is almost certain that contamination of municipal solid waste and sewage will persist for some time. However, because of the difficulties involved in locating and controlling the residual stocks of such dispersed materials any attempt to manage them is impractical.

Priority must therefore be accorded to the management of non-dispersed PCB liquids. Somewhat more than half the PCBs manufactured were used as dielectric fluids in transformers and capacitors, and a large proportion of this material is still in use. Control of the disposition of dielectric fluid is both feasible and necessary. As mentioned earlier, PCBs in this application were generally mixed with an organic solvent such as trichlorobenzene (TCB), and marketed in Canada under the generic designation of askarel. The amount of askarel in a transformer commonly ranges from 150 to 2000 litres with an average of 900 litres.

Askarel was only used intentionally in transformers located in or near buildings where the freedom from the fire and explosion hazards associated with the use of mineral oil as a dielectric fluid was required by underwriters' fire protection codes and government regulation. Such transformers were identified by a special code designation on their name plate. However, because of contamination that occurred either during their manufacture or servicing, it has been estimated that as many as 38 percent of mineral-oil transformers also contain low, but measurable, concentrations of PCBs.

In use, the dielectric fluid slowly becomes degraded, and thus may be replaced several times during the unit's service life. Transformers are also subject to occasional premature failure due to physical or mechanical deterioration. Where fire would not create a hazard, mineral oil is the preferred dielectric fluid; however, where a potential fire hazard exists, the substitution of alternative fluids, such as dimethyl silicone derivatives or blends of tri-and tetra-chlorobenzenes, for askarel may be made on the recommendation of the transformer manufacturer.

An alternative is the replacement of the wet-type transformer with the dry-type transformer, which may be either open to the atmosphere or gas-filled and sealed. Since this latter type of transformer is generally larger than an askarel-filled transformer of equivalent rating, space availability may limit the use of this alternative.

From the early 1930's until 1978 the use of askarel in capacitors was almost universal, and nearly all capacitors presently in use may be reasonably assumed to contain PCB (24). Since 1978, however, capacitor manufacturers have been manufacturing units filled wich acceptable alternatives to askarel, and the manufacture and import of askarel-filled capacitors was finally banned in Canada as of July 1, 1980 (Appendix B). Their occurrence may therefore be expected to decline. Capacitors have an average askarel content of 3 kg, with a range from 0.075 to 30 kg, and are used for power factor correction in inductive circuits or as ballasts in fluorescent lighting circuits. Since the units are hermetically-sealed, there is no parallel to the case of the transformer of replacing contaminated dielectric fluid during the course of the unit's life; however, premature failure may also occur for physical or mechanical reasons. Capacitor manufacturers are now manufacturing units filled with acceptable, alternative fluids to askarel.

Thus PCB-contaminated wastes may originate from any of these sources:

- dispersive applications;
- transformer decommissioning or failure;
- capacitor decommissoning or failure; and
- other industrial sources.

Since the manufacture or importation of all products containing dispersed PCBs has been prohibited for some years, release of PCBs into the environment from these sources will have been curtailed.

While the amount of askarel currently in transformer service in Ontario (approx. 6,000,000 litres) may appear large, the number of askarel-filled transformers only constitute some 5% of the total number of transformers (24). Since transformers have an expected service life of twenty to thirty years, the rate of generation of PCB waste from this source is also relatively slow. Each year a small number of transformer failures, either of a sudden or gradual nature, may be expected, and there is also a certain amount of askarel in stock which was originally intended for topping-up. Since this practice is now illegal, this latter material is a waste by definition.

Capacitors, for purposes of waste definition, have been arbitrarily divided into two classes based on their dielectric liquid content -- large and small. The majority of small capacitors (less than one kilogram of PCB) are expected to find their way into municipal solid waste, and, although their PCB content is encapsulated, the long-term degradation of the containers will eventually release the PCBs. Acceptable methods for the disposal of large capacitors and their contents have been dealt with in the PCB management guideline section. As with transformers, a number of failures may be expected annually, but an average unit life of ten to twenty years is the norm.

Normal servicing of transformers and the cleanup of catastrophic failures of both transformers and capacitors give rise to the final category of PCB contaminated wastes -- contaminated solids. These may take many forms, from rags through metal containers to soil upon which PCBs have been spilt. Decontamination or disposal of this type of waste poses problems because of the diverse nature of the solids which are contaminated and the intimate contact with the contaminant PCBs.

HANDLING AND STORAGE OF PCB's

In the handling, storage and transportation of PCBs, the overall objectives are to minimize release of this material into the natural environment and to minimize the direct exposure to the material of any persons handling it. These objectives may be attained through scrupulous adherence to the guidelines prepared for those purposes by Environment Canada, and through a systematic education and training of all persons involved in the operations(6).

Workers handling PCB materials, such as askarel, should at all times use the appropriate safety equipment. This has been detailed at length elsewhere, but consists generally of items designed to minimize opportunities for PCB inhalation, ingestion or skin adsorption. Fumes from hot askarel (above 55°C) are particularly irritating to the eyes and lungs. When hot material has to be handled, it is recommended that the forced air ventilation normally used in the work area during handling operations be supplemented by either an approved type of respirator or a self-contained breathing apparatus. Askarel is also a powerful solvent, and the use of certain materials, such as natural rubber, neoprene and PVC, in safety equipment should be avoided since they will eventually soften and dissolve.

First aid treatment for persons inadvertently exposed to direct contact with PCBs (or askarel) is intended to reverse the effects of exposure, e.g. washing with soap and warm water for skin contact, and referral to a physician is generally recommended as a follow-up. Workers exposed to PCBs should at all times observe scrupulous personal hygiene before eating, drinking or smoking.

When handling askarel, care should be exercised to avoid spilling it on the ground, and it is recommended that when transferring askarel from one container to another it be pumped to minimize the risk of spillage. The pump should be a specially-adapted, stainless steel, centrifugal one equipped with suitable askarel-resistant seals and hoses. Containers, pumps and any other equipment used for askarel should not be used for any other purpose unless they have been previously decontaminated using the recommended procedure. All containers should be appropriately labelled, and should be sealed when being moved from one location to another. Plastic containers are not advocated either for catching drips or storage since many plastics are soluble in askarel.

If PCB materials are to be transported, the shipper should ensure that suitable arrangements for its receipt have been made beforehand. An acceptable facility for receiving the material must exist at the destination; the transporter must be both authorized to handle and be capable of handling such materials, including the handling of such emergencies as spills and fires. All pertinent provincial, federal or foreign permits, waybills or other documentation should be in order, and a routing plan should be drawn up. The actual packaging and transportation methods to be employed may eventually be regulated. However, at the present time, guidelines on these topics exist, and these stipulate the acceptable practices to which shippers and transporters should adhere (6).

Because of the ever-present potential for environmental hazard associated with PCBs, the storage of askarel and PCB-contaminated materials must be of ongoing concern to their owner. They cannot just be set aside and forgotten. Storage may conveniently be considered as a three-faceted problem: initial steps for containment, long-term storage requirements (including regular monitoring) and measures to be taken if containment is breached.

Materials likely to require storage are transformers, capacitors, drummed liquids and contaminated solids, e.g. soil, rags, and discarded protective clothing. There is one basic principle in deciding how to store them: to ensure that PCBs do not escape into the natural environment. The required treatment initially for all the above categories except transformers is identical: they should be stored in good quality, heavy-gauge 45-gallon steel drums. Individual items should be placed in heavy-duty plastic bags, and the free space around them filled with an absorbent material such as sawdust. Apart from absorbing any leakage of fluids which may develop, the sawdust will also prevent materials shifting during transportation.

Transformers being taken out of service require special treatment. If a unit is in good mechanical condition, it may be stored with the dielectric fluid, be it askarel or askarel-contaminated mineral-oil, still in it. After being set in a suitably-sized containment tray, the unit should be crated and palletized. It may then be moved to a designated storage area. If the unit has deteriorated or is leaking, the liquid content should first be drained into suitable steel drums or barrels.

In selecting and developing a safe storage place for the barrels or transformers, there are four areas of concern which must be addressed -- containment, safety, security and monitoring. Ideally, these materials should be stored indoors. This will give total weather protection, provide opportunity for stronger security and offer less exposure to extremes of temperature. The area chosen should be well-ventilated, and, if frequent material transfer from one container to another is contemplated, be provided with its own forced-air ventilation system. The floor, preferably of concrete, should have no floor drains, and should have been treated with epoxy paint or an equivalent to prevent askarel being absorbed by concrete. Containment of any free fluid should be ensured by the provision of area curbs. All drums and transformers should be stored on pallets and not stacked to minimize risk of containers falling and rupturing. Together with the provision of adequate aisleways, these steps will facilitate day-to-day area security and periodic closer inspections. The whole PCB storage area should be capable of being segregated from other work areas and secured from unauthorized access, and furthermore it should be clearly labelled as to its contents. If for one reason or another, it is impossible to secure inside storage, outdoor storage may be effected. However, it is neither recommended nor desirable. The design features given in the various guidelines for indoor storage can be modified and implemented for outdoor storage, but the four key concerns cannot be so well addressed.

In addition to the personal safety program for normal handling previously outlined, measures to be taken in the case of fire or spills should be planned at the time the plans for the storage facility are being developed. In the case of fires, local fire services, both plant and municipal, should be familiar with both the physical plant and the special characteristics of burning and vaporized PCBs. Post-fire decontamination procedures are another aspect of fire safety education which should not be overlooked. In the case of spills it is essential to have well-trained personnel available and that they be adequately supplied with previously-stocked absorbent materials, wiping solvents and dyking equipment. A more detailed treatment of fire and spill management is provided in the federal PCB management guidelines(6).

PCB DISPOSAL

The safe and efficient disposal of accumulated liquid askarel, askarel-filled capacitors and other askarel-contaminated materials is one of concern to both the general public and to environmental regulatory bodies the world over. It is anticipated that current ambient levels of PCBs, already a global contaminant in the atmosphere, hydrosphere and biosphere, will inevitably increase slightly during the period in which existing stocks are gradually retired from service. Since both atmospheric and aquatic transport of PCBs are significant mechanisms for their introduction into the biosphere, only the use of those destruction and disposal techniques which have both a very high destruction efficiency and minimal environmental impact should be permitted.

A recent report published by Environment Canada has set forth the wide range of PCB destruction technology available, both proven and state-of-the-art (27). Before examining some of these destruction methods, it is, however, worthwhile to consider the reason for rejecting the use of so-called "chemically-secure" landfills as a disposal method for either large amounts of liquid PCBs or materials containing high concentrations of PCBs. Until recently, this practice was allowed in the United States for wastes containing less than 500 ppm PCB, provided the material was either stabilized or drummed. However, there is reason to believe that the landfilling of large quantities of such wastes may eventually result in the cumulative release of relatively large amounts of PCBs into the environment as the drums either rupture or corrode and release their contents.

Ambient air concentrations of PCB on and near a landfill used by a large capacitor manufacturer have been measured at levels up to five times the current U.S. occupational health standard(1). The extension or continuation of landfilling as a major disposal route should, therefore, not be considered as an acceptable method for the systematic disposal of PCBs either in large volumes or high concentrations. However, there is evidence that PCBs in low concentrations are selectively adsorbed by several types of soil. Thereafter they undergo a slow chemical degradation as a result of bacterial attack. The use of the landfill mechanism as a disposal method for solids contaminated with low concentrations of PCB should not therefore be entirely ruled out under proper and carefully-controlled circumstances, i.e. in the case of limited quantities of low-level PCB contaminated materials (7,8).

HIGH-TEMPERATURE DESTRUCTION METHODS

It is generally agreed that high-temperature incineration with an adequate retention time will safely and effectively destroy PCB molecules with a very high degree of efficiency. Some of these variants appears also to offer the greatest potential for high-rate, economically-acceptable PCB destruction, which, in view of the relatively large volumes of these materials to be disposed of, runs a close second to PCB destruction efficiency in technology selection. A number of avenues, both conventional and innovative, have been exploited to varying degrees. In Europe and the United States several high-efficiency incinerators are now in regular use. More innovative techniques such as those involving plasma are still under development, and the principal unresolved problem with all of them is whether or not toxic recombinant byproducts are formed, with primary interest focussed on PCDD and PCDF.

High-Efficiency Incinerator

Conventional municipal incinerators are not suitable for the destruction of PCBs; however, special high-temperature units fitted with adequate gas scrubbing and control systems may be used for this purpose. At the present time, there are several such units operating in Europe and the United States. Some of these are capable of handling both PCB-contaminated solids and liquids, others handle liquids only. The solids are first shredded and then processed in a rotary kiln; the high-efficiency incinerator in these systems operating as an afterburner for the vapours generated in the rotary kiln. The criteria for incinerator performance in Canada and the United States are a two-second dwell time at a minimum temperature of 1200°C (with a minimum of three percent excess oxygen in the stack gas), a combustion efficiency greater than 99.9% and a PCB destruction efficiency for solids of at least 99.9999%. Two American and two British units are known to meet or surpass the required criteria.

High-Efficiency Boiler

Based on the incinerator criteria, some industrial and utility boilers may be acceptable as devices to destroy materials such as mineral oil containing less than 500 ppm PCBs. These could either be blended with the regular feedstock and introduced into the boiler through a designated burner or volatilized in a pre-boiler combustion stage with the off-gas fed directly into the main boiler. One advantage with this latter method of introducing the PCBs is that the vapours can be introduced into a chosen area of the furnace. The proportion of PCBs in the boiler feed will have to be limited however, because one of the major by-products of askarel combustion is hydrogen chloride. In order to control its effect on the external environment in the neighbourhood of the boiler, and because of its potential for accelerated corrosion of the boiler surfaces, the production of hydrogen chloride will have to be limited.

A test burn conducted at Bay City, Michigan, achieved a combustion efficiency of 99.99%, well in excess of the EPA's required 99.9%. No PCDD or PCDF was detected in the exhaust gas using a method with a detectability limit of one part per billion. Ontario Hydro have also evaluated all their boilers. The conclusions were that, while most of their units have the capability of destroying PCBs and devices capable of approaching real-time monitoring of stack gases for PCB by-products are coming on the market, the corrosion potential in some cases might be a real deterrent to their use.

Rotary Kiln

A rotary kiln is an inclined, steel cylindrical shell with a refractory lining. Solid waste is introduced at the high end of the shell and liquid wastes are introduced at the low end (burning zone) of the shell. The liquid waste is either pre-blended with an auxiliary fuel (or other liquid waste of appropriate calorific value) and injected through the main burner nozzle or injected into the burning zone through a special nozzle. Rotary kilns are already in service in Europe and the United States specifically for the disposal of solid and liquid wastes; however, attention has also been directed to an industrial process which has used rotary kilns for many years to produce a commercial product, viz. cement. Several studies have been conducted on the use of cement kilns for the disposal of liquid chlorinated hydrocarbons in general, and PCBs in particular. All have been favourable; however, the only proposal to use a cement kiln for PCB disposal in Ontario which, to date, has been anywhere near implementation has been effectively blocked by local opposition.

Among the attractive features of the cement kiln incineration method are that the calorific value of the waste is utilized and a large part of the chlorine released during the disruption of the PCB molecules is beneficially absorbed into the cement clinker. The economics of the cement kiln process are also very favourable; being, at worst, the lowest cost method and at best some profit could be realized by the sale of the askarel to the kiln owner.

Multiple-Hearth Furnace

A multiple-hearth incinerator is a refractory-lined cylindrical shell with vertically-stacked refractory hearths. Solid wastes fed onto the top hearth are continuously raked by horizontal radial plows and fall through holes in successive hearths until they reach the furnace floor as an ash or clinker. Liquid wastes may be introduced with the solid wastes forming a slurry or sludge. The exhaust gas must then be passed through an efficient afterburner and HCl scrubber to destroy volatilized PCB and trap the hydrogen chloride formed. Test burns in existing furnaces have indicated that this type of system may be acceptable for PCB-contaminated solids.

Plasma Arc and Plasma Torch

Plasma is the so-called fourth state of matter, and consists of highly-energized, ionized gas molecules with equivalent temperatures as high as 50,000°K. In relaxing to their normal ground state, energy is given off by the molecules which may be absorbed by a substrate fed into the plasma. In this instance, the substrate is PCB waste. The feed material is itself atomized and ionized, i.e. molecular fracture occurs rather than the chemical oxidation characteristic of conventional incineration methods. In both instances there appears to be little doubt that the high energy available can destroy the original PCB molecules efficiently; there is, however, a need to determine that all the emission products are benign, i.e. to verify that PCDD, PCDF or other toxic entities are not recombinant emission products.

Both of the plasma developments appear to lend themselves to the mobile destructor concept. This would enable PCB wastes to be processed at a number of province-wide locations, and obviate the necessity to concentrate the waste materials at one or more large, stationary destructor units of other types.

Oxygen Incinerator

Pyro-magnetics Corporation of Whitman, Mass., have developed a mobile waste destruction system capable of handling a wide range of solid and liquid wastes, including PCBs. In 1982 the liquid waste portion of the system, known as the High-temperature Oxidizer, was approved by the United States Environmental Protection Agency (EPA) for the incineration of liquid PCBs. The liquid waste is injected into a high-temperature zone, and the resulting effluent gases are scrubbed to remove any residual contaminants. A destruction efficiency of 99.999943% was reported.

CHEMICAL DESTRUCTION METHODS

Several methods of treating PCB liquid waste chemically have been reported; however, only a few are known to have been commercialized to date. All, except one, have been based on what, for want of a better term, may be characterized as "sodium technology", i.e. sodium and sodium compounds in various combinations with other reagents under various conditions of temperature and pressure have been reacted with PCBs to form innocuous end products.

From published literature and news reports, it would appear that the application of these methods is restricted to dealing with low PCB concentrations (<10,000 ppm) on economic grounds (reagent costs, energy costs and/or throughput). One exception is the Rockwell molten salt system which can handle a wide range of chlorinated organics, solid or liquid at all concentrations. The Rockwell process uses a combination of relatively low incineration temperatures, long residence times and molten sodium carbonate to degrade the PCBs into 1-carbon compounds and to neutralize the resultant hydrochloric acid as soon as it is formed (25).

The exception to "sodium technology" is an acid digestion process reported by Westinghouse-Hanford. The organic waste feed is reacted with a mixture of concentrated sulphuric and nitric acids at temperatures of about 250°C. The behaviour of askarels under acid digestion is not well understood, but bench-scale experiments suggest that destruction efficiencies in excess of 99.9% can be achieved. It is known that Westinghouse-Hanford have operated a 5 kg/hr pilot plant using a variety of organic materials, but no reports on performance are available.

OTHER DESTRUCTION METHODS

Work has been going on for several years at the Lockheed Palo Alto Research Laboratory in California to develop a microwave detoxification process capable of handling toxic and refractory materials, including PCBs. Microwave-induced (100-100,000 Hz) electron reactions produce an ionized gas (plasma) from neutral gas molecules. At these frequencies, high ionization levels and molecular dissociation may be achieved without excessive heating of the contained gas. It is this feature plus an absence of electrodes which distinguishes this plasma reactor from the plasma torch and plasma arc previously described. A bench-scale unit has performed successfully, but commercialization is still a few years away on the most optimistic projection(2).

Experimental work was carried out in England in 1981 to assess the capability of a regular diesel engine operated in series with a gas scrubbing system to destroy liquid PCB waste. The Canadian proponent, Chemical Waste Management, a member of the D&D Group, is an Ontario company. Should the final evaluations of the system in Ontario prove favourable and the emissions comply with Ontario's regulations, the company intends to construct several mobile destruction units for local disposal of PCB wastes.

RETROFILLING AND DECONTAMINATION OF TRANSFORMERS

While the concept of retrofilling an askarel transformer, i.e. completely replacing its askarel content with a suitable substitute fluid, is attractive, attempts to attain the goal of permanently reducing the residual PCB concentration below 50 ppm economically have not been successful.

Triple rinsing with solvents, such as mineral oil or trichlorobenzene, will effectively decontaminate the casing of a previously-drained askarel transformer. However, in a relatively short period of time PCB fluid in the winding insulation will leach out into the replacement fluid. The latter must then either be replaced or treated to further remove residual PCBs. Cost data to date suggests that the cost of effective retrofilling of askarel transformers will in nearly all instances exceed the unit's replacement cost.

While drums, cans and similar containers of PCBs may be effectively decontaminated by solvent flushing and the resultant solid scrap disposed of in a landfill or salvaged, this method has not yet been successfully applied on a commercial scale to scrapped askarel transformers or capacitors. Ontario Hydro has researched this problem extensively, and concluded that, while it is possible to decontaminate these items, it would be necessary to install fairly elaborate equipment to handle the mechanical and physical problems involved.

LEGISLATION CONCERNING PCBs IN ONTARIO

The management of PCBs in Ontario is directly controlled by federal legislation:

Environmental Contaminants Act	(ECA)
Transportation of Dangerous Goods Act	(TDGA)

and provincial legislation:

Environmental Assessment Act	(EAA)
Environmental Protection Act	(EPA)
Dangerous Goods Transportation Act, 1981	(DGTA)
Occupational Health & Safety Act	(OHSA)
Ontario Water Resources Act	(OWRA)

It is also indirectly affected by United States' legislation:

Toxic Substances Control Act	(TSCA)

ENVIRONMENTAL CONTAMINANTS ACT (ECA)

The ECA, the stated purpose of which is to protect human health and the environment from substances that contaminate the environment, received assent in December, 1975. In September, 1977 this Act was amended to include chlorobiphenyls (PCBs) among the list of scheduled substances, and, at the same time, Chlorobiphenyl Regulations No. 1, was gazetted. This limited the commercial, manufacturing and processing uses of PCBs to certain, closed system uses, such as in electrical transformers and capacitors. On July 1, 1980, an amended regulation came into force which, among other things, specifically prohibited the use of PCBs in the operation of electromagnets in food processing or animal feed plants and their use as new filling or makeup fluid in transformers. Further regulations relating to PCB emissions into the general environment and to the sale or resale of equipment containing PCBs are under consideration, but have not yet been enacted (Appendix B).

TRANSPORTATION OF DANGEROUS GOODS ACT (TDGA)

This Act is intended to promote public safety in the transportation of dangerous goods, and was enacted in 1980. It applies to all federally regulated modes of transport, and, in particular, to interprovincial and international trucking. Regulations now in preparation will make it possible to control the international and interprovincial shipment of hazardous wastes, including PCBs, originating anywhere in Canada. Generators of PCB wastes will be compelled to identify them, comply with stipulated safety and labelling requirements and ensure that the intended disposal facility is acceptable.

ENVIRONMENTAL ASSESSMENT ACT (EAA)

The purpose of this Act is the betterment of the people of Ontario by providing for the protection, conservation and wise management of the Ontario environment. Under this legislation, certain undertakings, public or private, may be exposed to a process of evaluation involving a published government review of an EA on the undertaking; and, in certain cases, a public hearing by the Environmental Assessment Board or a Joint Board under the Consolidated Hearings Act, 1981. The public has the opportunity to scrutinize the EA and the review, make submissions to the Minister of the Environment on these matters including requiring a hearing on them, as well as participate fully when public hearings are held on the acceptability of the EA and/or the approval of the undertaking.

ENVIRONMENTAL PROTECTION ACT (EPA)

This Act, which is intended to provide for the protection and conservation of the natural environment, until recently had no provisions relating specifically to the management of PCBs. The relevant provisions of the Act were those relating to the approval and use of waste management facilities and any facility emitting contaminants to the natural environment.

However, in January, 1982, a new regulation (O.Reg. 11/82) relating directly to the management of PCBs in Ontario was gazetted. This essentially defines PCB material not in its design usage as a designated waste and therefore subject to the provisions of the waste management sections of the EPA. It also provides that owners of PCB wastes, having presently no other disposal facility available in Ontario, may establish PCB waste disposal (storage) sites on their own property with a minimum of complexity providing that they comply with certain stipulations laid down in the regulation. The regulation is intended to fulfill a temporary need arising from the present impasse on PCB storage and disposal in Ontario.

Guidelines for the regulation and sighting of mobile PCB destruction facilities have been issued as a discussion paper. The guidelines, amended following a public input process, will form the basis of a draft regulation. This draft regulation will be submitted to the public for further consultation. Following amendment to the draft regulation based on this public consultation, the draft regulation will be the subject of a public hearing before a hearing panel. Following consideration of the report of the panel, the government will decide whether a regulation is required and, if so, its final form.

ONTARIO WATER RESOURCES ACT (OWRA)

This legislation is similar in intent and structure to the EPA, but, in the context of PCB management, is concerned with contaminant emissions to the aquatic environment. Discharges to an approved municipal sewage works do not come under the OWRA, but are required to comply with that municipality's sewer use bylaw, which, may or may not contain regulatory levels of PCBs.

DANGEROUS GOODS TRANSPORTATION ACT 1981 (DGTA)

This is the provincial counterpart of the federal Transportation of Dangerous Goods Act (TDGA), and applies primarily to the role of intra-provincial trucking. Regulations covering a wide range of goods including PCBs are now being formulated for enforcement by Ministry of Transportation and Communications inspectors.

OCCUPATIONAL HEALTH AND SAFETY ACT (OHSA)

This Act, which is enforced by the Occupational Health and Safety Divison of the Ministry of Labour, is intended to protect the occupational health and safety interests of the worker, who is generally defined as a person performing work for monetary compensation, in the workplace, which is even more generally defined as "any land, premises, location or thing at, upon, in or near which a worker works". This far-reaching piece of legislation has particular relevance in the field of PCB management inasmuch as PCB is a toxic substance under the Act. The "use or manner of use" may be "prohibited, limited, restricted or made subject to any conditions the Ministry may specify". Therefore any aspect of the handling, transfer or transportation of PCBs may be subject to the control of the Ministry's inspectors.

TOXIC SUBSTANCES CONTROL ACT (TSCA)

TSCA was enacted by the United States Congress in 1976, and the EPA administrator was authorized under this legislation to develop a regulatory program for PCBs. In July, 1979, the so-called PCB Final Rule came into effect. This is a comprehensive PCB management document regulating the use and disposal of PCBs. With one or two exceptions, the regulation is concerned with only PCBs at concentrations of 50 ppm or greater. Its impact on Ontario's PCB management program concerns the prohibition on the import to the United States of PCB wastes, which has been, with one exception, in force since July 1, 1979. The re-opening of the international border would be contingent on Canada's adoption of a set of PCB controls equivalent to or stronger than those contained in the Final Rule.

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APPENDICES

APPENDIX A

ONT. REGULATION 11/82

UNDER THE ENVIRONMENTAL PROTECTION ACT

This regulation is currently being amended. A copy of proposed amendments appears on pp. A3-A4.

THE ENVIRONMENTAL PROTECTION ACT

O. Reg. 11/82.
Waste Management—PCBs.
Made—December 23rd, 1981.
Filed—January 15th, 1982.

REGULATION MADE UNDER THE ENVIRONMENTAL PROTECTION ACT

WASTE MANAGEMENT—PCBs

1. In this Regulation,

(*a*) "hold" includes own, possess and have care or control of and "holder" has a similar meaning;

(*b*) "PCB" means any monochlorinated or polychlorinated biphenyl or any mixture of them or any mixture that contains one or more of them,

(*c*) "PCB equipment" means equipment designed or manufactured to operate with PCB liquid or to which PCB liquid was added or drums and other containers used for the storage of PCB liquid;

(*d*) "PCB liquid" means,

(i) liquids, other than liquids used or proposed for use for road oiling, containing PCBs at a concentration of more than fifty parts per million by weight, and

(ii) liquids used or proposed for use for road oiling, containing PCBs at a concentration of more than twenty-five parts per million by weight;

(*e*) "PCB materials" means materials containing PCBs at a concentration of more than fifty parts per million by weight whether the material is liquid or not;

(*f*) "PCB waste" means,

(i) PCB equipment, or

(ii) PCB material,

but does not include,

(iii) PCB material or PCB equipment after it has been decontaminated pursuant to guidelines issued by the Ministry of the Environment or instructions issued by the Director,

(iv) PCB equipment that is,

(A) electrical equipment that has never contained over one kilogram of PCBs,

(B) electrical, heat transfer or hydraulic equipment or a vapour diffusion pump that is being put to the use for which it was originally designed or is being stored for such use by a person who uses such equipment for the purpose for which it was originally designed, or

(C) machinery or equipment referred to in sub-subclause (v) (B), or

(v) PCB liquid that,

(A) has been diluted to a concentration of fifty parts per million by weight or less pursuant to instructions from the Director,

(B) is at the site of machinery or equipment, the operation of which is intended to destroy the chemical structure of PCBs and with respect to which a certificate of approval has been issued under section 8 of the Act after the 1st day of

January, 1981 specifying the manner in which PCB liquid be processed in the machinery or equipment, or

(C) is in PCB equipment referred to in sub-subclause (iv) (B). O. Reg. 11/82, s. 1.

2. PCB waste is designated as a waste. O. Reg. 11/82, s. 2.

3. Every site upon which PCB waste and only PCB waste is situate is classified as a PCB waste disposal site. O. Reg. 11/82, s. 3.

4.—(1) Every operator of a waste disposal site shall keep records of all PCB waste held by him after the date this Regulation comes into force.

(2) The records referred to in subsection (1) shall include,

(*a*) the methods and times at which the PCB waste is received and delivered to and from the site, and

(*b*) where PCB waste is transported to and from the site, the location from or to which it is transported and the person by whom it is transported,

with respect to any delivery, receipt or transport of PCB waste after the date this Regulation comes into force, and

(*c*) a description of the nature and quantities of the PCB waste,

(*d*) the location of the waste disposal site, and

(*e*) the methods of storage of the PCB waste,

with respect to all PCB wastes at the waste disposal site.

(3) Every operator of a waste disposal site shall report to the Director the information required to be recorded under subsection (2),

(*a*) by telephone immediately, and in writing within three days, after a PCB waste first comes on the site, and

(*b*) in writing within thirty days after any other PCB waste is taken to or from the site.

(4) A record of a PCB waste transfer submitted to the Ministry under Regulation 313 of Revised Regulations of Ontario, 1980 satisfies the requirements of clauses (2) (*b*), (*c*) and (*d*) with respect to the PCB waste referred to in that record.

(5) Two years after an operator of a waste disposal site gives written notice to the Director that he has ceased to be a holder of PCB waste, he may dispose of records kept under subsection (1).

(6) Subsection (1) does not apply in respect of PCB waste that has been finally disposed of by burial before the 1st day of January, 1981. O. Reg. 11/82, s. 4.

5.—(1) A PCB waste disposal site is exempt from the provisions of sections 27, 39 and 40 of the Act.

(2) The exemption set out in subsection (1) is subject to the condition that,

(*a*) the operator of the site reports to the Director the information required to be recorded under subsection 4 (2);

(*b*) the operator of the site does not remove or permit to be removed,

(i) PCB waste containing over fifty litres of PCB liquid except in accordance with the written instructions of the Director,

(ii) any other PCB waste except,

(A) in accordance with written instructions of the Director, or

(B) to a waste management system or waste disposal site for which a certificate of approval has been issued after the 1st day of January, 1981 containing terms specifying the manner in which PCB waste may be stored, handled, treated, collected, transported, processed or disposed of;

(*c*) where there is any PCB liquid in electrical equipment or other container on the site, the operator of the site not remove the liquid from the container except,

(i) to transfer liquid from a leaking container upon notifying the Director of the transfer, or

(ii) pursuant to instructions of the Director; and

(*d*) no certificate of approval or provisional certificate of approval has been issued with respect to the site after the 1st day of January, 1981, specifying the manner in which PCB waste may be stored, handled, treated, collected, transported, processed or disposed of. O. Reg. 11/82, s. 5.

6. No person shall dispose of, decontaminate or otherwise manage PCb waste or dilute PCB waste that is in the form of a liquid except,

(*a*) in or to a waste management system operating under a certificate of approval issued after the 1st day of January, 1981 containing terms specifying the manner in which PCB waste may be stored, handled, treated, collected, transported, processed or disposed of; or

(*b*) in accordance with written instructions of the Director. O. Reg. 11/82, s. 6.

7. Every person storing PCB waste shall ensure that the PCB waste is in a safe and secure location so as to prevent PCB waste coming into contact with any person and so that any liquid containing PCBs that may escape can be readily recovered and will not discharge, directly or indirectly, into a watercourse or groundwater. O. Reg. 11/82, s. 7.

8. No person shall have at a waste disposal site PCB wastes received by the person after this Regulation comes into force unless,

(*a*) the PCB waste was delivered to the waste disposal site under written instructions of the Director; or

(*b*) the waste disposal site is operated under a certificate of approval containing a condition referring to this section and specifying the circumstances under which PCB waste may be accepted at the waste disposal site. O. Reg. 11/82, s. 8.

PROPOSED REGULATION TO AMEND ONTARIO REGULATION 11/82 MADE UNDER THE ENVIRONMENTAL PROTECTION ACT

1. (1) Clause 1(d) of Ontario Regulation 11/82 is revoked and the following substituted therefor:

(d) "PCB liquid" means,

(i) liquids, other than liquids used or proposed for use for road oiling, containing PCBs at a concentration of more than fifty parts per million by weight,

(ii) liquids used or proposed for use for road oiling, containing PCBs at a concentration of more than five parts per million by weight, and

(iii) liquids made contrary to section 6 by diluting liquids referred to in subclause (i) or (ii).

(2) Clause 1(f) of the said Regulation is revoked and the following substituted therefor:

(f) "PCB waste" means,

(i) PCB equipment,

(ii) PCB liquid, or

(iii) PCB material,

but does not include,

(iv) PCB material for PCB equipment after it has been decontaminated pursuant to guidelines issued by the Ministry of the Environment or instructions issued by the Director,

(v) PCB equipment that is,

(A) an electrical capacitor that has never contained over one kilogram of PCBs,

(B) electrical, heat transfer or hydraulic equipment or a vapour diffusion pump that is being put to the use for which it was originally designed or is being stored for such use by a person who uses such equipment for the purpose for which it was originally designed, or

(C) machinery or equipment referred to in sub-subclause (vi)(A), or

(vi) PCB liquid that,

(A) is at the site of fixed machinery or equipment, the operation of which is intended to destroy the chemical structure of PCBs by using the PCBs as a source of fuel or chlorine for purposes other than the destruction of PCBs or other wastes and with respect to which a certificate of approval has been issued under section 8 of the Act after the 1st day of January 1981 specifying the manner in which PCB liquid be processed in the machinery or equipment, or

(B) is in PCB equipment referred to in sub-subclause (v)(B).

2. Section 3 of the said Regulation is revoked and the following substituted therefor:

3.-(1) Every site containing PCB waste and PCB related waste but not containing other wastes is classified as a PCB waste disposal site.

(2) In subsection (1), "PCB related waste" means waste containing low levels of PCBs or waste arising from a spill or clean up of PCB liquid or PCB waste.

3. Section 5 of the said Regulation is amended by adding thereto the following subsection:

(3) In respect of a PCB waste disposal site that is offered for sale or lease or the possession of which is otherwise offered, the exemption set out in subsection (1) is subject to the conditions that,

(a) the person offering to sell, lease or otherwise give possession notifies, in writing,

(i) the prospective purchaser, tenant or person taking possession, of the existence of the site and the requirements, in law, concerning the site, and

(ii) the Director, of the sale, lease or change in possession; and

(b) where a sale, lease or change of possession occurs, the purchaser, tenant or person taking possession notifies, in writing, the Director, within ten days after the sale, lease or change of possession, of

(i) the location of the site, and

(ii) the nature and quantity of PCB waste.

4. Clause 6(a) of the said Regulation is amended by inserting after "processed" in the sixth line "diluted".

APPENDIX B

Registration
SOR/77-734 7 September, 1977

ENVIRONMENTAL CONTAMINANTS ACT

Chlorobiphenyl Regulations No. 1

P.C. 1977-2470 31 August, 1977

Whereas a copy of the proposed Regulation substantially in the form set out in the schedule hereto, was published in the *Canada Gazette* Part I on February 26, 1977;

And Whereas no notice of objection was filed with the Minister pursuant to subsection 5(3) of the Environmental Contaminants Act.

Therefore, His Excellency the Governor General in Council, on the recommendation of the Minister of Fisheries and the Environment and the Minister of National Health and Welfare, pursuant to paragraph 18(*c*) of the Environmental Contaminants Act, is pleased hereby to make the annexed Regulations prescribing certain uses in respect of which certain chlorobiphenyls may not be used.

REGULATIONS PRESCRIBING CERTAIN USES IN RESPECT OF WHICH CERTAIN CHLOROBIPHENYLS MAY NOT BE USED

Short Title

1. These Regulations may be cited as the *Chlorobiphenyl Regulations No. 1*.

Interpretation

2. In these Regulations,

"Act" means the *Environmental Contaminants Act*;

"chlorobiphenyls" means those chlorobiphenyls that have the molecular formula $C_{12}H_{10-n}Cl_n$ in which "n" is greater than 2;

"Minister" means the Minister of the Environment.

Prescription of Uses

3. For the purpose of subsection 8(2) of the Act, the following commercial, manufacturing and processing uses are hereby prescribed effective September 1, 1977, as uses in respect of which chlorobiphenyls may not be used:

(*a*) use in the operation, servicing or maintenance of any product, machinery or equipment other than

(i) electrical capacitors, electrical transformers and associated switchgear and machinery or equipment used to manufacture electrical capacitors, electrical transformers and associated switchgear,

(ii) heat transfer equipment, hydraulic equipment and vapour diffusion pumps that were designed to use

Enregistrement
DORS/77-734 7 septembre 1977

LOI SUR LES CONTAMINANTS DE L'ENVIRONNEMENT

Règlement sur les biphényles chlorés (n° 1)

C.P. 1977-2470 31 août 1977

Vu qu'une copie du Règlement proposé essentiellement dans la forme exposée à l'annexe ci-après a été publiée dans la *Gazette du Canada* (Partie I) le 26 février 1977;

Et vu qu'aucune objection n'a été formulée au ministre en vertu du paragraphe 5(3) de la Loi sur les contaminants de l'environnement.

A ces causes, sur avis conforme du ministre des Pêcheries et de l'Environnement ainsi que du ministre de la Santé nationale et du Bien-être social et en vertu de l'alinéa 18 *c*) de la Loi sur les contaminants de l'environnement, il plaît à Son Excellence le Gouverneur général en conseil de mettre en vigueur le Règlement ci-annexé interdisant certains emplois de certains biphényles chlorés.

RÈGLEMENT INTERDISANT CERTAINS EMPLOIS DE CERTAINS BIPHÉNYLES CHLORÉS

Titre abrégé

1. *Règlement sur les biphényles chlorés (n° 1).*

Définitions

2. On entend par

«biphényles chlorés» les byphényles dont la formule moléculaire est $C_{12}H_{10-n}Cl_n$ où «n» est plus grand que 2,

«loi» la *Loi sur les contaminants de l'environnement*,

«ministre» le ministre de l'Environnement.

Emplois interdits

3. Pour l'application du paragraphe 8(2) de la Loi, les emplois suivants des biphényles chlorés dans le commerce, la fabrication et la transformation sont interdits à compter du 1er septembre 1977:

a) les emplois dans l'exploitation, la réparation et l'entretien de tout produit, machinerie ou équipement sauf:

(i) les condensateurs électriques, les transformateurs électriques et l'appareillage connexe et la machinerie ou l'équipement servant à leur fabrication,

(ii) tout matériel de transfert de la chaleur, tout matériel hydraulique ou toute pompe à diffusion de vapeur utilisés au Canada avant le 1er mars 1977 et dont la conception exige l'emploi de biphényles chlorés et chlorobiphenyls and were in use in Canada before March 1, 1977, and

(iii) machinery or equipment, the operation of which is intended to destroy the chemical structure of chlorobiphenyls; and

(*b*) use as a constituent of any machinery, equipment or product manufactured in or imported into Canada after September 1, 1977 other than electrical capacitors, electrical transformers and associated switchgear.

(iii) la machinerie ou l'équipement destinés à détruire la structure chimique des biphényles chlorés et

b) les emplois dans les produits, la machinerie ou l'équipement fabriqués ou importés au Canada après le 1er septembre 1977, sauf les condensateurs électriques, les transformateurs électriques et l'appareillage connexe.

QUEEN'S PRINTER FOR CANADA, OTTAWA, 1977

IMPRIMEUR DE LA REINE POUR LE CANADA, OTTAWA, 1977

Registration
SOR/80-461 20 June, 1980

ENVIRONMENTAL CONTAMINANTS ACT

Chlorobiphenyl Regulations No. 1, amendment

P.C. 1980-1637 19 June, 1980

Whereas a copy of a proposed amendment to Chlorobiphenyl Regulations No. 1 was published in the *Canada Gazette* Part I on December 2, 1978, pursuant to section 5 of the Environmental Contaminants Act;

Whereas two notices of objection to the proposed amendment were filed with the Minister of the Environment and an Environmental Contaminants Board of Review, established in accordance with section 6 of the Act, conducted an inquiry in accordance with that section;

Whereas on February 25, 1980, the Board submitted its report to the Minister of the Environment and to the Minister of National Health and Welfare together with its recommendations and all evidence that was before the Board in accordance with subsection 6(4) of the Act;

And Whereas the report of the Board was made public by a Press Release dated March 26, 1980 and at a press conference held on March 26, 1980.

Therefore, His Excellency the Governor General in Council, on the recommendation of the Minister of the Environment and the Minister of National Health and Welfare, and in accordance with the recommendations of the Environmental Contaminants Board of Review, pursuant to paragraph 18(*c*) of the Environmental Contaminants Act, is pleased hereby to amend the Chlorobiphenyl Regulations No. 1, C.R.C., c. 564, in accordance with the schedule hereto.

SCHEDULE

1. Section 2 of the *Chlorobiphenyl Regulations No. 1* is revoked and the following substituted therefor:

"2. In these Regulations,

"Act" means the *Environmental Contaminants Act*;

"chlorobiphenyls" means those chlorobiphenyls that have the molecular formula $C_{12}H_{10-n}Cl_n$ in which "n" is greater than 2;

"electrical transformers" includes transformer/rectifier assemblies installed in a common enclosure;

"Minister" means the Minister of the Environment."

Enregistrement
DORS/80-461 20 juin 1980

LOI SUR LES CONTAMINANTS DE L'ENVIRONNEMENT

Règlement n° 1 sur les biphényles chlorés—Modification

C.P. 1980-1637 19 juin 1980

Vu qu'une copie d'un projet de modification au Règlement n° 1 sur les biphényles chlorés a été publiée dans la *Gazette du Canada*, Partie I, le 2 décembre 1978, en vertu de l'article 5 de la Loi sur les contaminants de l'environnement;

Vu que deux avis d'opposition à ce projet de modification ont été déposés auprès du ministre de l'Environnement et qu'une Commission d'étude sur les contaminants de l'environnement établie en vertu de l'article 6 de la Loi a fait enquête aux termes de cet article;

Vu que le 25 février 1980, la Commission a présenté son rapport au ministre de l'Environnement et au ministre de la Santé nationale et du Bien-être social, ainsi que ses recommendations et l'ensemble de la preuve dont elle a pris connaissance, conformément au paragraphe 6(4) de la Loi;

Et vu que ledit rapport a été rendu public le 26 mars 1980 par communiqué et conférence de presse.

À ces causes, sur avis conforme du ministre de l'Environnement et du ministre de la Santé nationale et du Bien-être social, suivant les recommandations de la Commission et en vertu de l'alinéa 18*c*) de la Loi sur les contaminants de l'environnement, il plaît à Son Excellence le Gouverneur général en conseil de modifier, conformément à l'annexe ci-après, le Règlement n° 1 sur les biphényles chlorés, C.R.C., c. 564.

ANNEXE

1. L'article 2 du *Règlement n° 1 sur les biphényles chlorés* est abrogé et remplacé par ce qui suit:

«2. Dans le présent règlement,

«biphényles chlorés» désigne les composés de la formule moléculaire $C_{12}H_{10-n}Cl_n$ où «n» est plus grand que 2;

«Loi» désigne la *Loi sur les contaminants de l'environnement*;

«Ministre» désigne le ministre de l'Environnement;

«transformateurs électriques» comprend les ensembles transformateurs/redresseurs installés dans une même enceinte.»

2. Section 3 of the said Regulations is revoked and the following substituted therefor:

"3. For the purpose of subsection 8(2) of the Act, the following commercial, manufacturing or processing uses are hereby prescribed as uses in respect of which chlorobiphenyls may not be used:

(*a*) use in the operation of any product, machinery or equipment other than

(i) electrical capacitors, electrical transformers and associated electrical equipment,

(ii) heat transfer equipment, hydraulic equipment, electromagnets, and vapour diffusion pumps that were designed to use chlorobiphenyls and were in use in Canada before September 1, 1977, and

(iii) machinery or equipment, the operation of which is intended to destroy the chemical structure of chlorobiphenyls;

(*b*) use in the operation of electromagnets that are used to handle food, animal feed or anything intended to be added to food or animal feed for any purpose whatsoever;

(*c*) use as a constituent of any product, machinery or equipment manufactured in or imported into Canada after September 1, 1977, other than electrical capacitors, electrical transformers and associated electrical equipment;

(*d*) use as a constituent of electrical capacitors, electrical transformers and associated electrical equipment manufactured in or imported into Canada after July 1, 1980;

(*e*) use in the servicing or maintenance of any product, machinery or equipment, other than electromagnets, electrical transformers and associated electrical equipment; and

(*f*) use as new filling or as make-up fluid in the servicing or maintenance of any electromagnet, electrical transformer or associated electrical equipment."

3. Sections 1 and 2 shall come into force on July 1, 1980.

2. L'article 3 dudit règlement est abrogé et remplacé par ce qui suit:

«3. Aux fins du paragraphe 8(2) de la Loi, les emplois suivants des biphényles chlorés dans le commerce, la fabrication ou la transformation sont interdits:

a) l'emploi dans l'exploitation de tout produit, machinerie ou équipement, sauf

(i) les condensateurs électriques, les transformateurs électriques et l'équipement électrique connexe,

(ii) l'équipement de transfert de la chaleur, l'équipement hydraulique, les électro-aimants et les pompes à diffusion de vapeur conçus pour utiliser des biphényles chlorés et mis en service au Canada avant le 1^{er} septembre 1977, et

(iii) la machinerie ou l'équipement destinés à détruire la structure chimique des biphényles chlorés;

b) l'emploi dans l'exploitation d'électro-aimants utilisés pour la manutention d'aliments destinés à l'homme ou aux animaux ou de leurs additifs;

c) l'emploi dans les produits, la machinerie ou l'équipement fabriqués ou importés au Canada après le 1^{er} septembre 1977, sauf les condensateurs électriques, les transformateurs électriques et l'équipement électrique connexe;

d) l'emploi dans les condensateurs électriques, les transformateurs électriques et l'équipement électrique connexe fabriqués ou importés au Canada après le 1^{er} juillet 1980;

e) l'emploi pour la réparation ou l'entretien des produits, de la machinerie ou de l'équipement autres que les électro-aimants, les transformateurs électriques et l'équipement électrique connexe; et

f) l'emploi comme nouveau fluide de remplissage ou comme fluide d'appoint pour la réparation ou l'entretien des électro-aimants, des transformateurs électriques ou de l'équipement électrique connexe.»

3. Les articles 1 et 2 entrent en vigueur le 1^{er} juillet 1980.

EXPLANATORY NOTE

(This note is not part of the Regulation, but is intended only for information purposes.)

These amendments now have the following effects:

(1) The use of chlorobiphenyls is restricted to use in those items listed in subparagraphs 3(*a*)(i), (ii) and (iii).

(2) Paragraph 3(*b*) prohibits the use of chlorobiphenyls in the operation of electromagnets that are used to handle food, animal feed or anything intended to be added to food or animal feed for any purpose whatsoever.

(3) Paragraph 3(*c*) prohibits the use of chlorobiphenyls as a constituent of any product manufactured in or imported into Canada after September 1, 1977, other than electrical capacitors, electrical transformers and associated electrical equipment.

(4) Subsection 3(*d*) removes, effective July 1, 1980, the exemption regarding electrical capacitors, electrical transformers and associated electrical equipment so that thereafter the use of chlorobiphenyls is totally prohibited as a constituent of any product, machinery or equipment manufactured in or imported into Canada.

(5) Paragraph 3(*e*) allows the use of chlorobiphenyls after July 1, 1980 in the servicing or maintenance of electromagnets, electrical transformers and associated electrical equipment. This means, for example, that existing chlorobiphenyls may be removed, filtered and returned to the same piece of equipment. However, in paragraph 3(*f*) the use of additional chlorobiphenyls as a new filling or as make-up in servicing or maintenance is prohibited. This does not, though, prohibit the use of a suitable non-chlorobiphenyl fluid as a new filling or as make-up.

NOTE EXPLICATIVE

(La présente note ne fait pas partie du règlement et n'est publiée qu'à titre d'information.)

Ces modifications qui entrent en vigueur le 1er juillet 1980 visent:

(1) à limiter l'emploi de biphényles chlorés dans l'exploitation de tout produit, machinerie ou équipement sauf certains articles;

(2) à interdire leur emploi dans les électro-aimants utilisés pour la manutention dans l'industrie alimentaire;

(3) à interdire leur emploi dans les produits fabriqués ou importés au Canada après le 1er septembre 1977, sauf les condensateurs électriques, les transformateurs électriques et l'équipement électrique connexe;

(4) à ne plus exempter les articles visés au paragraphe (3) de la présente note;

(5) à interdire leur emploi pour la réparation ou l'entretien des produits de la machinerie ou de l'équipement sauf certains articles;

(6) à interdire leur emploi comme nouveau fluide de remplissage ou comme fluide d'appoint pour la réparation ou l'entretien de certains articles.

QUEEN'S PRINTER FOR CANADA, OTTAWA, 1980 IMPRIMEUR DE LA REINE POUR LE CANADA, OTTAWA, 1980

DEPARTMENT OF THE ENVIRONMENT

ENVIRONMENTAL CONTAMINANTS ACT

Proposed Regulations Respecting the Concentration of Chlorobiphenyls in Certain Products and the Release of Chlorobiphenyls into the Environment

Notice is hereby given pursuant to subsection 5(2) of the Environmental Contaminants Act*, that the Minister of the Environment and the Minister of National Health and Welfare propose to recommend to the Governor in Council that the annexed Regulations be made

(*a*) prescribing pursuant to paragraph 18(*e*) of that Act the maximum concentration of chlorobiphenyls that may be contained in certain products; and

(*b*) prescribing pursuant to paragraph 18(*a*) of that Act the maximum quantity and concentration of chlorobiphenyls that may be released into the environment.

Examination of the combined socio-economic impact of these two Regulations has concluded that they are minor regulations according to Treasury Board of Canada's criteria for identification of the economic impact of Health, Safety or Fairness Regulations. The summary of that examination is published herewith.

Any person having an interest therein may, within 60 days of the publication of this notice, file a notice of objection with the undersigned.

Given at Ottawa, this 21st day of January, 1984

CHARLES CACCIA
Minister of the Environment

MINISTÈRE DE L'ENVIRONNEMENT

LOI SUR LES CONTAMINANTS DE L'ENVIRONNEMENT

Projet de règlement sur la concentration de biphényles chlorés dans certains produits et sur le rejet de biphényles chlorés dans l'environnement

Avis est donné par la présente, en vertu du paragraphe 5(2) de la *Loi sur les contaminants de l'environnement**, que le ministre de l'Environnement et le ministre de la Santé nationale et du Bien-être social se proposent de recommander au Gouverneur général en conseil qu'il établisse

a) en vertu de l'alinéa 18*e*) de cette Loi, le Règlement sur les concentrations maximales permises de biphényles chlorés dans certains produits; et

b) en vertu de l'alinéa 18*a*) de cette Loi, le Règlement sur les quantités et les concentrations maximales de biphényles chlorés qui peuvent être rejetées.

L'étude de l'impact socio-économique combiné de ces deux règlements a mené à la conclusion qu'il s'agit de règlements mineurs selon les critères du Conseil du Trésor du Canada pour l'identification de l'impact économique des règlements sur la santé, la sécurité ou l'équité. Le résumé de cette étude est publié ci-après.

Tout intéressé peut, dans un délai de 60 jours suivant la date de publication du présent avis, faire parvenir un avis d'opposition au soussigné.

Ottawa, le 21 janvier 1984

Le ministre de l'Environnement
CHARLES CACCIA

REGULATION PRESCRIBING THE MAXIMUM CONCENTRATION OF CHLOROBIPHENYLS THAT MAY BE CONTAINED IN CERTAIN PRODUCTS

Short Title

1. This Regulation may be cited as the *Chlorobiphenyl Regulations No. 2 (Product)*.

Interpretation

2. In these Regulations,

"Act" means the Environmental Contaminants Act;

"electrical transformer" includes a rectifier-transformer assembly installed in a common enclosure.

Prescription

3. (1) For the purpose of subsection 8(4) of the Act, the maximum concentration prescribed in respect of chlorobiphenyls contained in a product that is

(*a*) an electrical capacitor,

(*b*) an electrical transformer and its associated electrical equipment,

RÈGLEMENT PRESCRIVANT LA CONCENTRATION MAXIMALE DE BIPHÉNYLES CHLORÉS DANS CERTAINS PRODUITS

Titre abrégé

1. Le présent règlement peut être cité sous le titre: ***Règlement nº 2 sur les biphényles chlorés (produits)***.

Définitions

2. Dans le présent règlement,

«Loi» désigne la *Loi sur les contaminants de l'environnement*;

«transformateur électrique» comprend un ensemble transformateur-redresseur installé dans une même enceinte.

Concentration prescrite

3. (1) Aux fins du paragraphe 8(4) de la Loi, la concentration maximale prescrite de biphényles chlorés dans

a) un condensateur électrique,

b) un transformateur électrique et l'équipement électrique connexe,

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* S.C. 1974-75-76, c. 72.

* S.C. de 1974-75-76, c. 72.

(*c*) an electro-magnet,

(*d*) heat transfer equipment,

(*e*) hydraulic equipment, or

(*f*) a vapour diffusion pump

designed to use chlorobiphenyls, is 50 parts per million by weight of the liquid therein.

(2) Subsection (1) does not apply to the concentration of chlorobiphenyls in a product referred to in paragraphs (1)(*a*) to (*f*) that is offered for sale as a necessary and integral part of an immovable building, plant or structure that is offered for sale.

c) un électro-aimant,

d) l'équipement de transfert de la chaleur,

e) l'équipement hydraulique, ou

f) une pompe à diffusion de vapeur,

conçu pour utiliser des biphényles chlorés, est de 50 parties par million, en poids, du liquide s'y trouvant.

(2) Le paragraphe (1) ne s'applique pas aux produits visés aux alinéas (1)*a*) à *f*) qui sont mis en vente en tant que partie essentielle ou intégrante d'un immeuble, d'une installation ou d'une structure non déplaçables mis en vente.

EXPLANATORY NOTE

(*This note is not part of the Regulations, but is intended only for information purposes.*)

These Regulations will prescribe the maximum concentration of chlorobiphenyls that may be contained in the listed products at the time they are imported, manufactured or knowingly offered for sale.

NOTE EXPLICATIVE

(*La présente note ne fait pas partie du règlement et n'est publiée qu'à titre d'information.*)

Ce règlement prescrit la concentration maximale de biphényles chlorés qui est permise dans certains produits au moment où ils sont importés, fabriqués ou sciemment mis en vente.

REGULATIONS PRESCRIBING THE MAXIMUM CONCENTRATION AND QUANTITY OF CHLOROBIPHENYLS THAT MAY BE RELEASED

Short Title

1. These Regulations may be cited as the *Chlorobiphenyl Regulations No. 3 (Release)*.

Interpretation

2. In these Regulations,

"Act" means the Environmental Contaminants Act;

"electrical transformers" includes rectifier-transformer assemblies installed in a common enclosure;

"package" means any receptacle or enveloping material that contains any of the equipment referred to in section 4.

Maximum Concentration

3. For the purposes of subsection 8(1) of the Act, the maximum concentration of chlorobiphenyls that may be released into the environment in any geographical area of Canada, other than any water or place to which subsection 33(2) of the Fisheries Act applies, in the course of

(*a*) a commercial, manufacturing or processing activity, other than

  (i) an application to a road surface, or

  (ii) an activity described in section 4

is 50 parts per million by weight; and

(*b*) an application to a road surface, is five parts per million by weight.

RÈGLEMENT FIXANT LA CONCENTRATION ET LA QUANTITÉ MAXIMALES DE BIPHÉNYLES CHLORÉS QUI PEUVENT ÊTRE REJETÉES

Titre abrégé

1. Le présent règlement peut être cité sous le titre: *Règlement n° 3 sur les biphényles chlorés (rejets).*

Définitions

2. Dans le présent règlement,

«emballage» désigne un contenant ou un matériau servant à envelopper ou à protéger les pièces d'équipement visées à l'article 4;

«Loi» désigne la *Loi sur les contaminants de l'environnement*;

«transformateur électrique» comprend un ensemble transformateur-redresseur installé dans une même enceinte.

Concentration maximale

3. Aux fins du paragraphe 8(1) de la Loi, la concentration maximale de biphényles chlorés qui peut être rejetée dans l'environnement dans une région du Canada, sauf les eaux ou les lieux visés au paragraphe 33(2) de la *Loi sur les pêcheries*,

a) dans le cadre d'une opération commerciale, de fabrication ou de traitement, autre

  (i) qu'un traitement de surface d'une route, ou

  (ii) qu'une opération visée à l'article 4,

est de 50 parties par million en poids; et

b) au cours d'un traitement de surface d'une route, est de cinq parties par million en poids.

Maximum Quantity

4. For the purposes of subsection 8(1) of the Act, the maximum quantity of chlorobiphenyls that may be released into the environment in any geographical area of Canada, other than any water or place to which subsection 33(2) of the Fisheries Act applies, in the course of the operation, servicing, maintenance, decommissioning, transportation or storage of

(*a*) electrical transformers and associated electrical equipment manufactured in or imported into Canada before July 1, 1980,

(*b*) electro-magnets designed to use chlorobiphenyls and manufactured in or imported into Canada before September 1, 1977,

(*c*) electrical capacitors manufactured in or imported into Canada before July 1, 1980, or

(*d*) heat transfer equipment, hydraulic equipment or vapour diffusion pumps designed to use chlorobiphenyls and in use in Canada before September 1, 1977,

is 1 g per day

(*e*) for any one piece of equipment, or

(*f*) for any one package of equipment.

EXPLANATORY NOTE

(*This note is not part of the Regulations, but is intended only for information purposes.*)

These Regulations will prescribe the maximum concentration and quantity of chlorobiphenyls that may be released into the environment in the prescribed geographical area of Canada in the course of commercial, manufacturing and processing activities.

SUMMARY OF THE SOCIO-ECONOMIC IMPACT ANALYSIS (SEIA) OF THE PROPOSED CHLOROBIPHENYL REGULATIONS NO. 2 (PRODUCT) and CHLOROBIPHENYL REGULATIONS NO. 3 (RELEASE)

1. Polychlorinated biphenyls (PCBs) are toxic organic compounds that are persistent in the environment and bioaccumulate in the human food chain. The use of PCBs is regulated in Canada by Chlorobiphenyl Regulation No. 1, made under the authority of the Environmental Contaminants Act (ECA). The Department of the Environment is proposing to make two new regulations, Chlorobiphenyl Regulation No. 2 (Product) and Chlorobiphenyl Regulation No. 3 (Release), also under the authority of the ECA, that will further restrict the dispersion of PCBs in the environment.

2. Departmental policy requires that the costs and benefits to Canadians of regulatory control initiatives taken by the Department be examined and made available to the public for review. Preliminary analyses indicated that the incremental costs of the regulations might exceed the cost criteria for major Health, Safety and Fairness (HSF) Regulations established by Treasury Board. The examination of costs and

Quantité maximale

4. Aux fins du paragraphe 8(1) de la Loi, la quantité maximale de biphényles chlorés qui peut être rejetée dans l'environnement dans une région du Canada, sauf les eaux ou les lieux visés au paragraphe 33(2) de la *Loi sur les pêcheries*, au cours de l'exploitation, de l'entretien, de la réparation, de la mise hors service, du transport ou de l'entreposage

a) d'un transformateur électrique et de l'équipement électrique connexe, fabriqués ou importés au Canada avant le 1er juillet 1980,

b) d'un électro-aimant conçu pour utiliser des biphényles chlorés et fabriqué ou importé au Canada avant le 1er septembre 1977,

c) d'un condensateur électrique fabriqué ou importé au Canada avant le 1er juillet 1980, ou

d) de l'équipement de transfert de la chaleur, de l'équipement hydraulique ou d'une pompe à diffusion de vapeur conçus pour utiliser des biphényles chlorés et utilisés au Canada avant le 1er septembre 1977,

est de 1 g par jour

e) pour chaque pièce d'équipement, ou

f) pour chaque emballage d'équipement.

NOTE EXPLICATIVE

(*La présente note ne fait pas partie du règlement et n'est publiée qu'à titre d'information.*)

Ce règlement prescrit la quantité et la concentration maximales de biphényles chlorés qui peuvent être rejetées dans l'environnement à certains endroits au Canada, au cours d'opérations commerciales, de fabrication et de traitement.

RÉSUMÉ DE L'ANALYSE DE L'IMPACT SOCIO-ÉCONOMIQUE (AISE) DES PROJETS DE RÈGLEMENTS N° 2 (PRODUITS) et N° 3 (REJETS) SUR LES BIPHÉNYLES CHLORÉS

1. Les biphényles polychlorés (BPC) sont des matières organiques toxiques et persistantes qui s'accumulent dans la pyramide trophique de l'homme. Au Canada, leurs usages sont assujettis au Règlement n° 1 sur les biphényles chlorés, promulgués sous le régime de la *Loi sur les contaminants de l'environnement (LCE)*. Le ministère de l'Environnement envisage deux nouveaux règlements, le n° 2 sur les produits et le n° 3 sur les rejets, toujours sous le régime de la LCE, pour limiter davantage leur dispersion dans l'environnement.

2. Le Ministère a pour règle d'examiner les coûts et les avantages pour les Canadiens, de la réglementation qu'il envisage et de les porter à la connaissance du public. D'après ses analyses préliminaires, les coûts marginaux liés aux nouveaux règlements pouvaient dépasser les critères de coût attachés aux règlements importants dans les domaines de la santé, de la sécurité et de l'équité (SSE) et établis par le Conseil du

benefits has therefore been carried out in accordance with Treasury Board requirements for socio-economic impact analysis (SEIA).

3. Rigorous cost-benefit analysis of these regulations was not attempted because of the inability to develop meaningful estimates of the economic value of the benefits. Cost-effectiveness analysis has instead been used to provide an indication of the relative efficiency of these regulations when compared to other regulations and activities with similar goals. Cost-effectiveness ratios have been presented for events for which meaningful estimates could be determined, such as the expected reduction in spills of PCB fluids and incidents of human exposure to PCBs. Health-related benefits have been addressed in a qualitative manner by discussion of the known effects of PCB and description of past incidents of PCB release that are similar to the types of events the regulations are intended to help prevent. The time horizon used for the study is forty-five years since essentially all currently operating PCB equipment will have reached end-of-life in that time.

4. The results of this analysis show that the two proposed regulations will not have a major effect on the Canadian economy, according to the criteria established by Treasury Board. The estimated net present value (in 1982 dollars) of the combined incremental costs (considered because the regulations will be promulgated in the same year) is $11.4 million. The net present value of the largest single year incremental cost is estimated to be $1.22 million, occurring in the first year that the regulations are in effect (assumed to have been 1982 in this study).

5. It is estimated that the social costs associated with implementation of Chlorobiphenyl Regulation No. 2 would have a net present value of approximately $2.2 million. (These and all other cost estimates presented here have been discounted to 1982 dollars at a 10% annual discount rate). Approximately $1.7 million of this cost would be incurred by owners of redundant PCB equipment, due to the loss in net value that would be expected because of the requirement to reduce the PCB concentration in the contained liquid to below 50 ppm prior to sale of the equipment. Enforcement of the Regulation would make up the remaining $0.5 million of the estimated cost.

6. The expected social cost of Chlorobiphenyl Regulation No. 3 is estimated to have a net present value of approximately $9.2 million. This is comprised of costs for increased equipment inspection and other measures to ensure compliance with the Regulation ($3.87 million), destruction costs for waste PCB that would otherwise be wilfully released into the environment ($2.35 million), enforcement and compliance costs ($2.49 million) and costs for additional analysis of used oil intended for application to road surfaces ($0.45 million).

7. The sensitivity of the cost estimates to changes in the assumptions used in the study was examined. The three most difficult areas to predict—road oil analytical requirements, quantities of PCB wilfully disposed and the date of availability of PCB destruction capability—were investigated. The analysis showed that, within the ranges considered, there would be no change to the "minor" economic effect status of the regulations. A direct relationship between costs and changes to the first two areas mentioned above exists; however, the estimated

Trésor. L'examen des coûts et des avantages s'est donc reporté, conformément aux prescriptions du Conseil du Trésor, à l'analyse de l'impact socio-économique.

3. Il n'a pas été tenté d'analyse rigoureuse du rapport coûts/avantages de ces règlements à cause de l'impossibilité d'estimer de façon significative la valeur économique des avantages. On s'est plutôt servi de l'analyse du rapport coût/efficacité pour obtenir une idée de l'efficacité relative de ces règlements comparativement aux autres règlements et activités dont les buts sont similaires. Certains rapports coût/efficacité ont été dégagés pour les événements qu'on pouvait estimer de façon significative, tels que la réduction prévue des déversements de fluides contenant des BPC et les cas d'exposition humaine aux BPC. Les avantages pour la santé ont été traduits de façon qualitative, compte tenu des effets connus des BPC et des cas de rejet de BPC similaires à ceux que les règlements devraient empêcher. L'horizon de l'étude est de 45 années, car tout l'équipement actuellement en exploitation qui contient des BPC aura essentiellement atteint, d'ici là, la fin de sa durée de service.

4. L'analyse montre que les deux projets de règlement n'auront pas d'effets majeurs sur l'économie canadienne, si on se fie aux critères du Conseil du Trésor. La valeur actualisée nette (en dollars de 1982) des coûts marginaux considérés dans leur ensemble (parce que les règlements seront promulgués la même année) est estimée à 11,4 M$ au total. Pour une seule année, son maximum est estimé à 1,22 M$, et il s'agit de la première année que les règlements sont en vigueur (c'est-à-dire, 1982, hypothèse de l'étude).

5. On estime que les coûts sociaux de la mise en vigueur du Règlement n° 2 atteindraient 2,2 M$ en valeur actualisée nette. (Ces coûts estimatifs et tous les autres qui sont présentés ici ont été ramenés en dollars de 1982 à raison d'un taux annuel d'actualisation de 10 %. De ces coûts, 1,7 M$ seraient à la charge des propriétaires de l'équipement superflu, qui avant d'être vendu devrait renfermer des fluides dont la teneur en BPC doit être ramenée à moins de 50 ppm, ce qui entraînerait une baisse de valeur nette. La mise en vigueur du Règlement contribuerait au 0,5 M$ résiduel.

6. Le coût social prévu du Règlement n° 3 est estimé à 9,2 M$, en valeur actualisée nette. Il comprend les coûts de l'inspection accrue de l'équipement et des autres mesures visant à assurer le respect du Règlement (3,87 M$), les coûts de la destruction des BPC résiduaires qui, autrement, seraient délibérément rejetés dans l'environnement (2,35 M$), les coûts de l'exécution du règlement et de la conformité à ce dernier (2,49 M$) et les coûts des analyses supplémentaires des huiles usagées destinées à l'abattement des poussières des routes (0,45 M$).

7. On a examiné dans quelle mesure ces estimations étaient sensibles aux modifications des hypothèses qui ont servi à l'étude. Les trois points les plus difficiles à prédire (besoins analytiques des huiles épandues sur les routes, quantité de BPC délibérément éliminée et date de démarrage des installations de destruction des BPC) ont été examinés. L'analyse montre que, dans la période considérée, il n'y aurait aucune modification des effets économiques mineurs des règlements. Il existe une relation directe entre les coûts et les modifications

costs were found to be essentially independent of changes in the availability of PCB destruction facilities.

8. The major benefits of Chlorobiphenyl Regulation No. 2 will be in the area of occupational exposure to PCB. It is estimated that the sale of approximately 400 redundant PCB transformers could be affected by the Regulation, resulting in the early removal from service of about 520 tonnes of PCB fluid. There will be a corresponding reduction of about 100 fewer spills (totalling about 3 tonnes) of PCB fluid and about 7700 fewer incidents of potential worker exposure during maintenance and spill clean-up activities than would be expected if the PCBs were permitted to remain in service in the redundant equipment until its natural end-of-life. These reductions represent approximately 5% of the total spills and maintenance activities that would be expected over the 45-year study time horizon.

9. Chlorobiphenyl Regulation No. 3 will have its greatest impact on human health and environment quality by reducing the potential for significant exposure to PCB through ingestion of contaminated foods and fish or exposure to contaminated soil and water. Under the assumptions used in the analysis, the Regulation could prevent wilful release into the environment of between 850-900 tonnes of PCB.

10. The Regulations will have other less easily measured benefits. Both regulations will provide assistance to industry in economic planning exercises. The removal of PCBs from service required by Regulation No. 2 will occur with a minimum of disruption to industry (in terms of plant operation) because removal is not required until such time that the equipment has become redundant to the needs of the current owner. This Regulation will also prohibit the importation of PCBs contained in electrical equipment into Canada for the purpose of scrap recovery. Such practices increase, to some extent, the risk of additional human exposure to PCBs and environmental damage from uncontrolled releases of PCB.

11. The cost-effectiveness analysis examined three efficiency indicators that could be estimated—the quantity of PCB removed from service prior to normal end-of-life equipment attrition, the reduced number of potential workplace exposure incidents, and the expected reduction in the quantity of PCB released into the environment. The costs of the regulations were then expressed in terms of their relationship to these indicators. The ratios that were developed show that the costs associated with each indicator were in the order of $4.30/kg PCB removed from service prior to normal equipment end-of-life, $63.00/hour reduction in workplace exposure, and $10-13/kg PCB fluid prevented from release into the environment. These ratios are comparable to similar ratios developed for other control measures and activities with similar goals.

12. Certain aspects of the PCB problem greatly limited the feasible technological alternatives to these regulations. This resulted in an early emphasis on the regulatory approach as proposed. The status quo is unacceptable because of the government's commitment to the OECD regarding the elimination of PCBs from the environment. The legal status of regulations also provides the deterrents deemed necessary to ensure compliance. The proposed regulations also complement the prohibitions of the Fisheries Act and maintain compatibility with other federal and provincial control actions.

aux deux premiers points mentionnés; toutefois, les coûts estimatifs se sont révélés essentiellement indépendants de l'accessibilité des installations de destruction.

8. Les principaux avantages du Règlement n° 2 toucheront l'exposition aux BPC en milieu de travail. On estime que la vente d'environ 400 transformateurs superflus contenant des BPC pourrait, du fait du Règlement, aboutir à la mise au rancart prématurée d'environ 520 t de fluides contenant des BPC. Il y aura réduction correspondante d'une centaine de déversements (totalisant 3 t) de fluides contenant des BPC et de 7 700 cas d'exposition au cours de l'entretien et du ramassage des fluides déversés par rapport à ce qu'on pourrait prévoir si on tolérait les BPC dans l'équipement superflu jusqu'à sa fin naturelle de durée de service. Ces réductions représentent environ 5 % du total des déversements et de l'entretien prévu au cours des 45 années prospectées.

9. Le Règlement n° 3 aura son maximum d'incidences sur la santé humaine et la qualité de l'environnement, en réduisant les possibilités d'exposition notable aux BPC par l'ingestion d'aliments ou de poisson contaminés ou par l'exposition au sol et à l'eau contaminés. D'après les hypothèses de base de l'analyse, il pourrait prévenir le rejet délibéré dans l'environnement de 850 à 900 t de BPC.

10. Les Règlements auront d'autres avantages plus difficiles à mesurer. Ils aideront la planification économique de l'industrie. La mise au rebut des BPC, exigée par le Règlement n° 2, perturbera l'industrie de façon minimale (pour ce qui est de l'exploitation des usines) parce qu'elle n'est pas exigée avant que l'équipement ne devienne superflu par rapport aux besoins du propriétaire actuel. Le même règlement interdira aussi l'importation, au Canada, de BPC contenus dans l'équipement électrique, en vue de la récupération de la ferraille, cette dernière activité accroissant dans une certaine mesure le risque d'exposition aux BPC et de dommages à l'environnement, suite aux rejets incontrôlés du BPC.

11. L'analyse du rapport coût/efficacité a porté sur trois indicateurs de l'efficacité qui pouvaient être estimés: la quantité de BPC mis au rebut avant la fin normale de la période de service de l'équipement; le nombre réduit des cas potentiels d'exposition en milieu de travail; et la réduction prévue des rejets de BPC dans l'environnement. Les coûts des Règlements ont ensuite été exprimés en fonction de ces indicateurs. Les rapports ainsi calculés montrent que les coûts liés à chaque indicateur sont de l'ordre de 4,30 $/kg de BPC mis au rebut avant la fin normale de la durée de service de l'équipement, de 63,00 $/h de réduction de l'exposition professionnelle et de 10 à 13 $/kg de fluides contenant des BPC qu'on empêche de s'échapper dans l'environnement. Ces rapports se comparent avec des rapports semblables mis au point pour d'autres mesures et activités qui ont un objet similaire.

12. Certains aspects du problème posé par les BPC ont fortement réduit le nombre de solutions techniques de rechange aux Règlements, ce qui eut comme résultat de mettre tôt en évidence l'approche réglementaire proposée. Le statu quo est inacceptable en raison des engagements pris par le gouvernement envers l'OCDE en vue de débarrasser l'environnement des BPC. En droit aussi, les Règlements fournissent les moyens de dissuasion jugés nécessaires pour assurer qu'on s'y conformera. Ils ajoutent aussi aux interdictions de la *Loi sur les pêcheries* et restent compatibles avec les autres modalités de contrôle instituées par les gouvernements fédéral et provinciaux.

13. Neither regulation is expected to have any significant non-allocative effects on the Canadian economy.

The complete version of this Socio-Economic Impact Analysis can be obtained from:

Dr. D. G. Kelley
Director, External Strategies Branch
Environmental Protection Service
Department of the Environment
Ottawa, Ontario K1A 1C8

[3-1-o]

13. Les Règlements ne devraient pas avoir d'effets d'allocation sur l'économie canadienne.

La version intégrale du rapport d'analyse peut être obtenue de:

D. G. Kelley
Directeur des Stratégies externes
Service de la protection de l'environnement
Ministère de l'Environnement
Ottawa (Ontario) K1A 1C8

[3-1-o]

APPENDIX C

CO-COMBUSTION OF LIQUID CONTAINING 50 PPM PCB OR LESS

(1) Thermal destruction is an accepted method of destroying organic liquid wastes.

(2) Co-combustion is a thermal destruction process in which the liquid organic waste is mixed with conventional boiler fuel for firing in industrial boilers.

(3) The primary purpose of industrial boilers is the production of energy for on-site process needs. Only certain industrial boilers shall be deemed eligible for co-combustion of non-designated PCB liquid wastes. Each particular application shall be subject to approval by the Approvals Branch of the Ministry of the Environment.

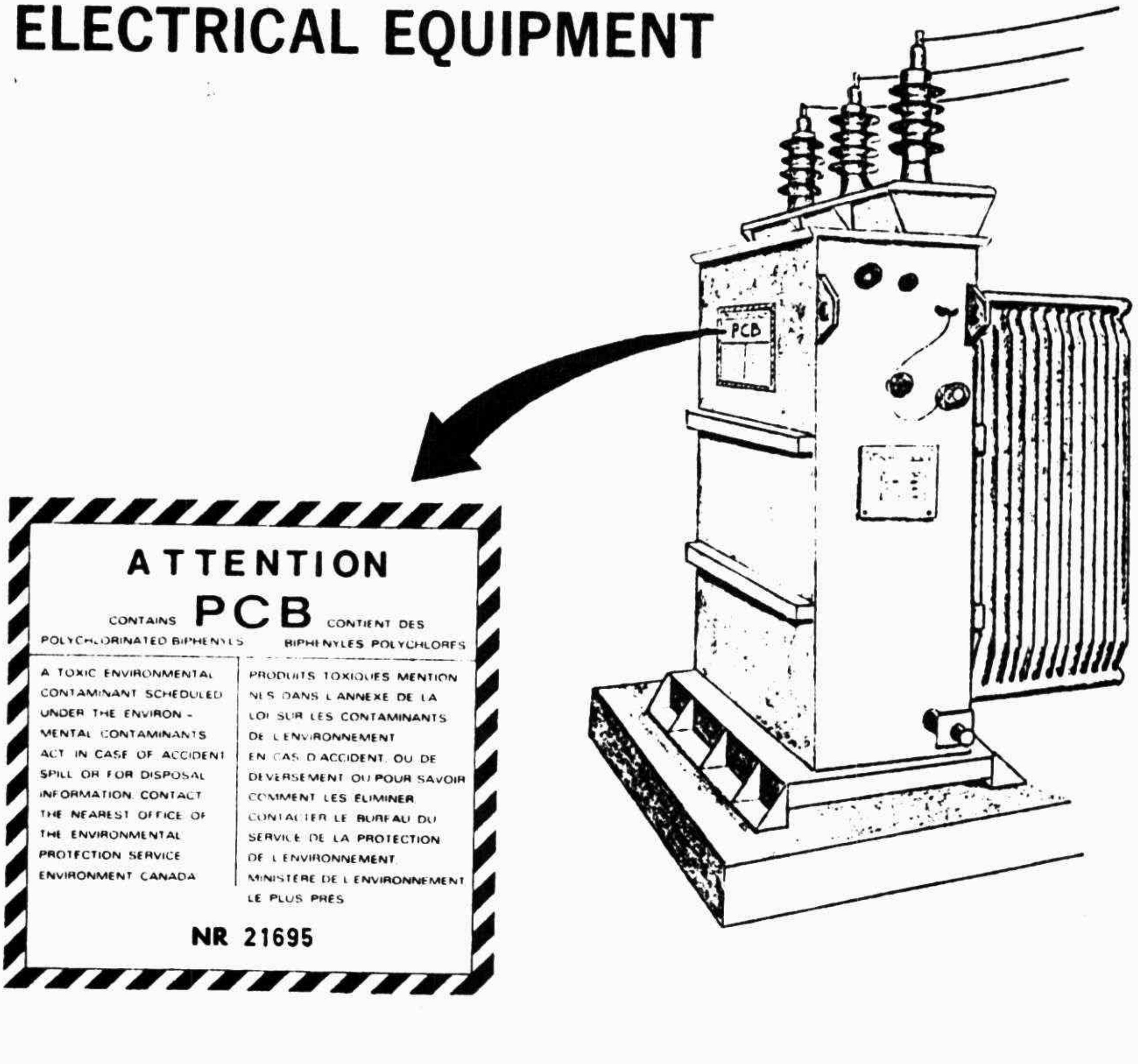
(4) The minimum requirements for eligibility are that the boiler be of the water-tube type with a rated capacity equal to or in excess of twenty-five thousand per hour 150 psig saturated steam. In determining overall suitability, the Approvals Branch will take into account the following factors:

- the type and condition of burner(s);
- time and temperature profile of the boiler; and
- the stack configuration as a determinant in downwind dispersion.

(5) The use of co-combustion as a waste disposal process for liquids containing 50 ppm PCB or less shall be limited to non-continuous (batchwise) applications, and, in no case, shall the liquid constitute more than 10% of the normal fuel as fired.

APPENDIX D

HANDBOOK on PCBs in ELECTRICAL EQUIPMENT



ATTENTION

CONTAINS **PCB** CONTIENT DES

POLYCHLORINATED BIPHENYLS BIPHENYLES POLYCHLORES

A TOXIC ENVIRONMENTAL CONTAMINANT SCHEDULED UNDER THE ENVIRONMENTAL CONTAMINANTS ACT. IN CASE OF ACCIDENT, SPILL OR FOR DISPOSAL INFORMATION, CONTACT THE NEAREST OFFICE OF THE ENVIRONMENTAL PROTECTION SERVICE, ENVIRONMENT CANADA

PRODUITS TOXIQUES MENTIONNES DANS L'ANNEXE DE LA LOI SUR LES CONTAMINANTS DE L'ENVIRONNEMENT. EN CAS D'ACCIDENT, OU DE DEVERSEMENT OU POUR SAVOIR COMMENT LES ELIMINER, CONTACTER LE BUREAU DU SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT, MINISTERE DE L'ENVIRONNEMENT LE PLUS PRES

NR 21695

Canada

HANDBOOK ON PCBs IN ELECTRICAL EQUIPMENT

Edited by

J. de Gonzague
S. Lawrie

Environmental Protection Service
Environment Canada

First Edition, March 1981
Revised Edition, December 1982

Disponible en français

s'adresser au:

Coordonnateur des publications
Direction générale du contrôle des incidences
environnementales
Service de la protection de l'environnement
Environnement Canada
Ottawa (Ontario)
K1A 1C8

et demander:

Les BPC et l'équipement électrique

©Minister of Supply and Services Canada 1983

Cat. No. En47-310/1983E

ISBN 0-662-12347-6

ABSTRACT

This handbook provides comprehensive information on the maintenance, transportation and storage of electrical equipment containing PCBs. Information is given concerning the handling of out-of-service equipment containing PCBs. The handbook also presents information pertaining to PCB spills.

RÉSUMÉ

Ce manuel offre toutes les informations nécessaires pour l'entretien, le transport et l'entreposage de l'équipement électrique contenant des BPC. Il donne également des renseignements sur la manipulation de l'équipement hors d'usage et au le traitement des déversements de BPC.

FOREWORD

Much of the material presented in Chapters 1 to 7 of this handbook was originally compiled by Stothert Engineering Ltd. of Vancouver, B.C., and presented to the Pacific and Yukon Region of Environment Canada in eight booklets. Chapter 8, on PCB substitutes, is a summary of parts of a report provided by M.M. Dillon Ltd.

The information gathered by the above companies was condensed and edited by Stella Lawrie, under contract to the Environmental Protection Service (EPS), and by John de Gonzague, Publications Coordinator, Environmental Impact Control Directorate, EPS.

Inquiries pertaining to the contents of this handbook should be directed to the Environmental Impact Control Directorate, Environmental Protection Service, Environment Canada, Ottawa, Ontario, K1A 1C8, or to the EPS Regional Office listed in the Appendix.

ACKNOWLEDGEMENTS

This handbook could not have been prepared without the valuable and accurate information provided by Stothert Engineering Ltd. and M.M. Dillon Ltd.

Much appreciated critical reviews of the initial draft of the handbook were obtained from EPS staff, in particular, Laurie Solsberg, Douglas Wilson, Doug Harvey-Smith and Bill Logan.

The cheerful and efficient assistance of the EPS Word Processing Centre is sincerely acknowledged. As well, the fine work of Barney Townshend in modifying and colour-enhancing the illustrations provided by Stothert Engineering Ltd. is deeply appreciated.

The Module d'édition française, especially Yann Plunier, is thanked for the attention given to the accuracy of the French version of the handbook.

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1 INTRODUCTION

Polychlorinated biphenyls (PCBs) are man-made liquids that are highly stable, non-corroding and relatively nonflammable. These and other characteristics such as excellent insulating and thermal properties have contributed to their widespread use.

First synthesized in 1881, PCBs were not manufactured on a commercial scale until 1929. Since that time, however, many applications have been developed. These include use in:

- waxes
- adhesives
- heat exchange fluids
- vacuum pump oils
- paints
- dedusting agents
- specialized lubricants
- printing inks
- pesticides
- cutting oils
- carbonless copying paper
- caulking compounds

and electrical transformers, capacitors, and switchgear.

This report concerns the uses of PCBs in electrical equipment. Non-flammable chlorinated aromatic hydrocarbon electrical insulating fluids used in electrical equipment are known as "askarels". When PCBs are present, they are part of a series of complex mixtures of PCBs, chlorinated benzenes and trace contaminants. In this report these askarel mixtures which contain PCBs will be called "PCB liquids". Brand names for PCB liquids include:

Apirolio (Italy)
Aroclor (U.S.A. and Great Britain)
Asbestol
Chlorextol
Clophen (Germany)
Clorinol
Diaclor
DK (Decachlorodiphenyl) (Italy)
Dykanol
Elemex
Eucarel
Fenclor (Italy)
Hyvol
Inerteen (Canada and U.S.A.)
Kanechlor (Japan)
Montar (U.S.A.)
No-Flamol
Phenoclor (France)
Pydraul (U.S.A.)
Pyralene (France)
Pyranol (Canada and U.S.A.)
Pyroclor (Great Britain)
Saf-T-Kuhl
Santotherm FR (Japan)
Sorol (U.S.S.R.)
Therminol FR (U.S.A.)

1.1 Hazards of PCBs

For many years, isolated reports in industrial medical literature concerning the toxic effects of PCBs caused little general interest. More recently, however, public awareness was aroused by a number of incidents, the most serious being the contamination of rice oil in Japan (1968) which affected over 1000 people.

The contamination resulted from the leaking of PCBs from equipment in a food processing plant. The PCB liquids mixed with rice oil and the incident went unnoticed. People who consumed the rice oil developed, over an extended period of time, various medical problems.

1.2 Exposure to PCBs

The 1968 incident in Japan is an obvious case of PCB poisoning. There are other less obvious ways in which PCBs may contaminate the environment and create a hazard to human health.

PCBs, which leak from damaged or rusted electrical equipment or which are spilled onto the ground, can eventually seep into streams, rivers and lakes. PCBs may also inadvertently be poured directly into sewage drains.

Once in the environment, PCBs can be accumulated by various life forms, and contamination is passed up the food chain. Fish ingest PCBs in the water; animals consume the contaminated fish; and man consumes the contaminated fish and animals.

Liquid PCBs vapourize and become airborne, especially through improper incineration. PCBs may then be dispersed by the wind and deposited back on earth in rain and snowfall. For this reason, PCB liquids and other products containing PCBs should only be burned in facilities designated for that purpose. Scientists are presently studying the feasibility of using special high temperature furnaces (temperatures in excess of 1000°C) for the destruction of PCBs.

Individuals who are involved in maintenance of electrical transformers and capacitors, or who are involved in the cleanup of spilt PCB liquids, can accidentally come into contact with these liquids. The chapters which follow give details on how to deal with PCB liquids and PCB-contaminated equipment, and how to control spills.

1.3 Government Controls and Guidelines

Manufacture and importation of PCBs or products containing PCBs are regulated under the federal Environmental Contaminants Act. As of July 1, 1980, when the amendment to PCB Regulations No. 1 (1 Sept., 1977) came into effect, the following restrictions apply:

1. PCBs may not be used in the operation of any product, machinery, or equipment except:
    a) electrical capacitors, electrical transformers and associated electrical equipment;
    b) heat transfer equipment, hydraulic equipment, electromagnets and vapour diffusion pumps that were designed to use PCBs and were in use in Canada before September 1, 1977; and
    c) machinery or equipment which is intended to destroy the chemical structure of PCBs.
2. PCBs are prohibited from use in the operation of electromagnets that are used to handle food, animal feed or anything intended to be added to food or animal feed.
3. PCBs may not be used as a constituent of any product, machinery or equipment manufactured in or imported into Canada after September 1, 1977, except electrical capacitors, electrical transformers and associated electrical equipment.
4. PCBs are prohibited from use as a constituent in electrical capacitors, electrical transformers, and associated electrical equipment manufactured in or imported into Canada after July 1, 1980.
5. PCBs may be reused in the servicing and maintenance of electromagnets, electrical transformers and associated electrical equipment (i.e. removed, filtered and returned to the same piece of equipment), but may not be used in the servicing or maintenance of any other product, machinery or equipment.
6. The use of PCBs as a new filling fluid or as a make-up fluid in servicing or maintenance is prohibited. Substitute (non-PCB) fluids may be used, however.

In addition, Government guidelines declare that any substance that contains more than 0.005% by weight or 50 ppm of PCBs is considered to be contaminated and must be treated as a PCB substance. Examples include:

- PCB liquids (askarels with PCB content);
- mineral oil contaminated with PCBs;
- certain hydraulic and heat exchange fluids;
- rinsing solvents;
- components from PCB-liquid transformers and capacitors, and heat transfer systems; and
- containers for PCB wastes and unused fluids.

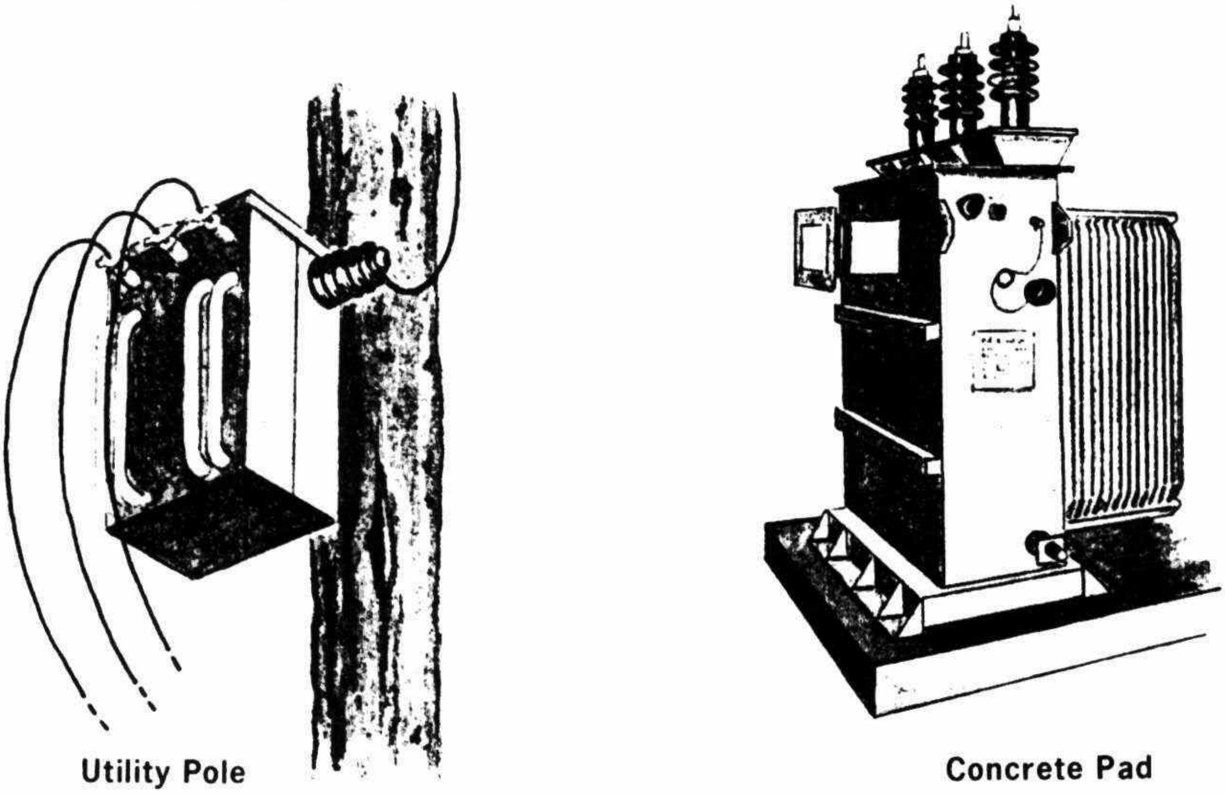
2 THE USE OF PCBs IN ELECTRICAL EQUIPMENT

2.1 Identification of PCB-liquid Transformers

Transformers come in a variety of shapes and sizes. Some, ***usually*** smaller ones, are a dry type and do not contain any liquids. In transformers containing dielectric fluid, the fluid also serves as a heat exchanger. Heat from the windings is transferred to the casing. If the heat transfer capacity of a transformer casing is not sufficient, cooling tubes or fins may be added. These operate like a car radiator. Most larger transformers are characterized by these tubes or fins. Transformers may be located:

- inside a building (usually along a wall);
- inside a building enclosed in a concrete vault or electrical room;
- on the roof;
- underground (usually in mines only);
- outside on a concrete pad; and,
- outside on a utility pole.

Some companies may utilize a variety of locations for a number of transformers (see Figure 1).



Utility Pole **Concrete Pad**

FIGURE 1 LOCATIONS OF TRANSFORMERS

Transformers located within a building must be nonflammable and, therefore, are usually filled with PCB liquids. To minimize fire risk, mineral oil transformers have to be housed within a special vault if they are used inside a building.

PCB-liquid and mineral oil transformers can usually be distinguished by the transformer nameplate, which is located on the outside casing. The nameplate details the manufacturer, the amount and type of liquid (if liquid filled) and gives technical particulars. If one of the brand names listed in Section 1 appears on the nameplate, the transformer contains PCBs.

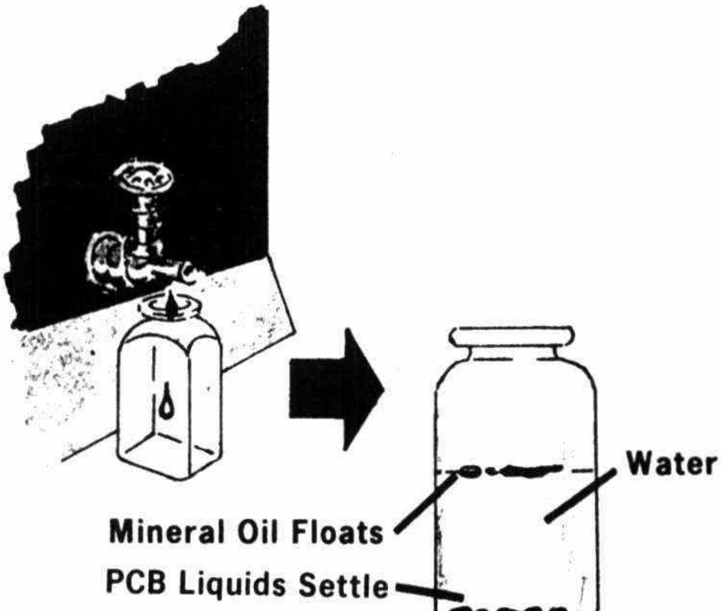
The Type Number also indicates if the transformer contains PCB liquids. Any Type Number beginning with "L" indicates that PCB liquids are used in the transformer. Some Type Numbers are; LFAF, LFAN, LFWN, LNAF, LNP, LNS, LNW, and LNWN. Any Type Number beginning with "O" indicates that the transformer contains oil; one common Type Number is ONAN.

If there is uncertainty about the contents of the transformer, a simple test may be conducted as follows:

1) Clean the drain spout at the base of the transformer with a clean rag.
2) Drain a few drops of the liquid into a clean glass flask and add a small amount of water.

If it is a PCB liquid, it will settle on the bottom; if it is mineral oil, it will float. If the liquid does neither, it indicates that the liquid has been contaminated and should be taken to a laboratory for professional analysis. **Do not pour test material back into the transformer; water will degrade its electrical performance.**

If the test indicates the presence of PCB liquids, dispose of the sample contents as instructed in Section 4 concerning the handling and disposal of PCBs.



2.2 Identification of PCB-liquid Capacitors

Capacitors allow for the more efficient use of electrical power through power factor correction. They vary in size considerably, from the size of an ice cube to much larger than a refrigerator. Capacitors in light ballasts usually have two electrical terminals extending from one end of the hermetically-sealed metal casing. Larger capacitors may have three or more electrical terminals.

For power factor correction of induction furnaces, capacitors may be wired together in a "bank" for increased capacitance (see Figure 2).

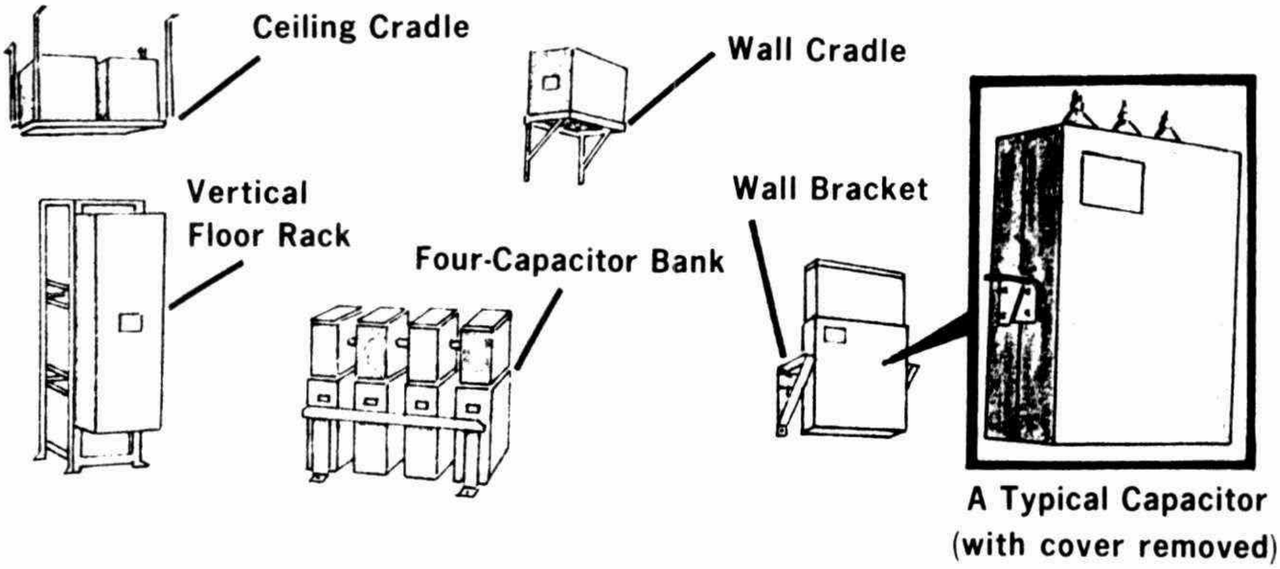


FIGURE 2 TYPICAL CAPACITOR LOCATIONS

Capacitors may be found in a variety of locations within a building:

- wired to the electrical terminals of A.C. motors (if 30 horsepower or larger), electric welders and induction furnaces;
- in the plant area, wired to bus bars feeding a row of motors or electric welders;
- connected to motor control centre panels; or
- connected to the main service cables inside the electrical room.

Capacitors are usually installed in cool, dry areas to allow efficient operation.

Capacitors used with lamp ballasts are usually encased with the ballast transformer and sealed inside the light fixture or are positioned at a remote distance from the fixture. Capacitors located outdoors are usually enclosed in a weatherproof, welded, steel housing of rectangular construction.

A capacitor often can be recognized by the letters KVAR stamped on its nameplate. These letters indicate the electrical sizes of capacitors which most often fall within the 5 KVAR to 200 KVAR range.

Capacitors are hermetically sealed to reduce leakage risk and, therefore, cannot be tested to verify the contents. However, almost every electrical capacitor manufactured since the 1930s has been made with PCB liquids, so it must be assumed that all capacitors still in existence today contain PCBs, except where alternative (non-PCB) liquids are clearly indicated on the nameplate of new equipment.

2.3 Identification of PCB Liquids

The most obvious characteristic difference between PCB liquids and mineral oil is the strong odour of PCB liquids (see Table 1). If there is any doubt, however, laboratory analysis should be undertaken.

TABLE 1 PHYSICAL CHARACTERISTICS OF PCB LIQUIDS

Colour	↔	crystal clear to pale yellow
Vapours	↔	invisible
Odour	↔	bitter smell
Texture	↔	somewhat slippery
Weight	↔	heavier than water

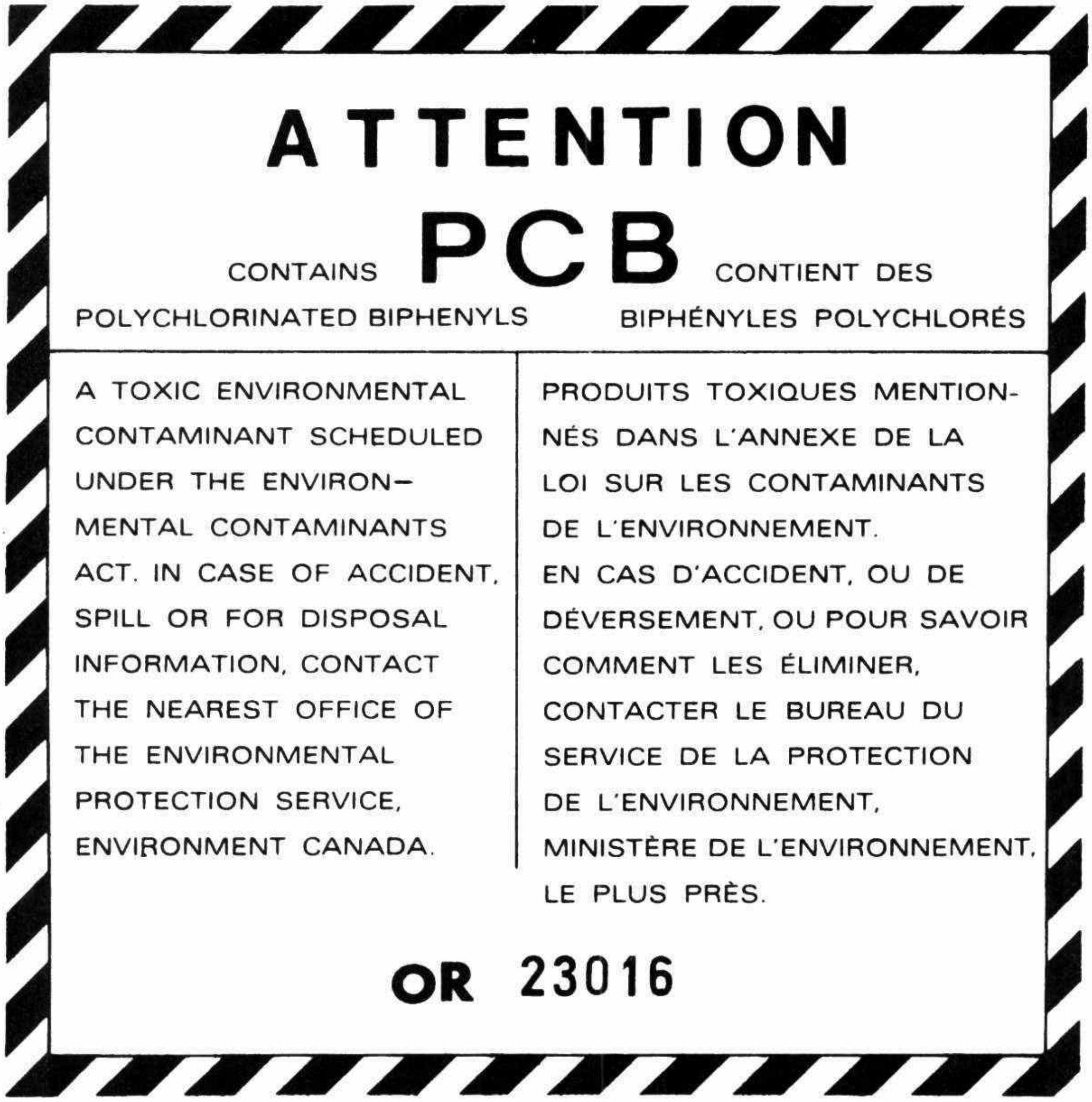
Note: PCBs have also been shipped in a solid state and may be found in the vicinity of electrical equipment in this form. There are 11 grades in all, some liquid and others solid, which differ primarily in their chlorine content.

Used PCB liquids do not usually have the same physical appearance as when new. They may become contaminated with dirt, moisture, black carbon particles (from arcing) and pieces of insulation from the inside of the equipment. These particles degrade the performance of the PCB liquids and cloud or darken their appearance.

2.4 Labelling System for PCBs

The Environmental Protection Service has developed a labelling system to alert people to the presence of PCBs in equipment and to allow preparation of an inventory of PCBs contained in equipment and stored awaiting disposal.

A 7.6 x 7.6 cm label is placed on the casing of small items such as capacitors, while a 15 x 15 cm label is available for PCB transformers and drums containing PCB liquids (see Figure 3). Each label has a registration number, and should **never** be removed



ATTENTION

CONTAINS **PCB** CONTIENT DES

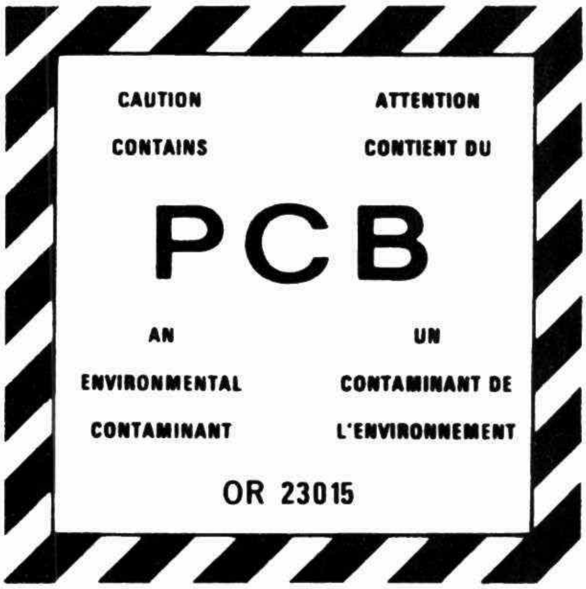
POLYCHLORINATED BIPHENYLS BIPHÉNYLES POLYCHLORÉS

A TOXIC ENVIRONMENTAL CONTAMINANT SCHEDULED UNDER THE ENVIRONMENTAL CONTAMINANTS ACT. IN CASE OF ACCIDENT, SPILL OR FOR DISPOSAL INFORMATION, CONTACT THE NEAREST OFFICE OF THE ENVIRONMENTAL PROTECTION SERVICE, ENVIRONMENT CANADA.

PRODUITS TOXIQUES MENTIONNÉS DANS L'ANNEXE DE LA LOI SUR LES CONTAMINANTS DE L'ENVIRONNEMENT. EN CAS D'ACCIDENT, OU DE DÉVERSEMENT, OU POUR SAVOIR COMMENT LES ÉLIMINER, CONTACTER LE BUREAU DU SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT, MINISTÈRE DE L'ENVIRONNEMENT, LE PLUS PRÈS.

OR 23016

a) LABEL FOR LARGE EQUIPMENT



CAUTION ATTENTION

CONTAINS CONTIENT DU

PCB

AN UN

ENVIRONMENTAL CONTAMINANT DE

CONTAMINANT L'ENVIRONNEMENT

OR 23015

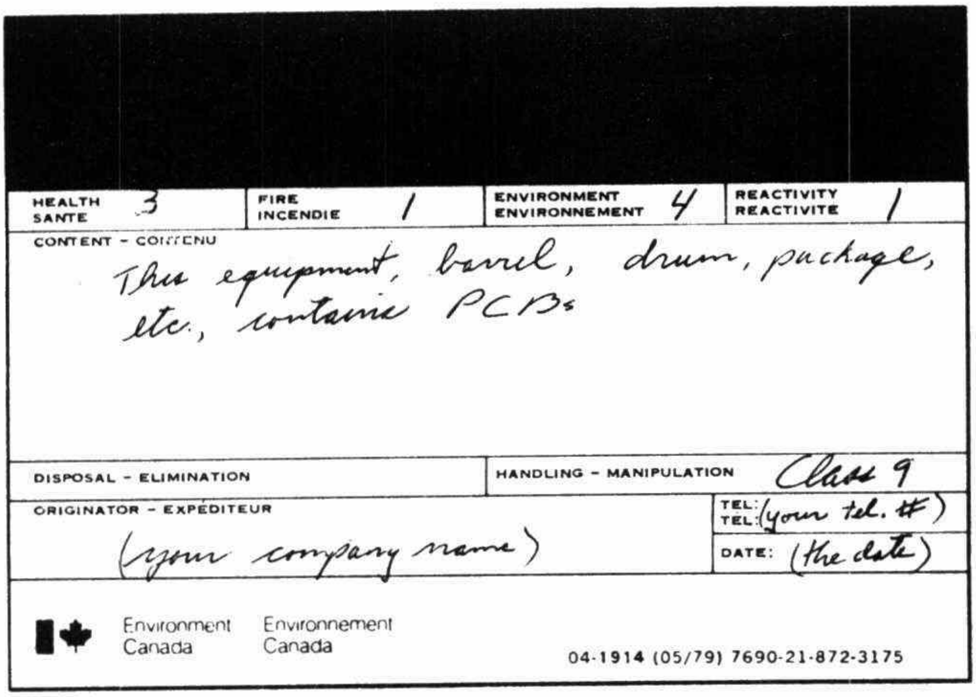
b) LABEL FOR SMALL EQUIPMENT

FIGURE 3 LABELS FOR PCB EQUIPMENT

from the equipment, unless the equipment has been retrofilled with another liquid and the Environmental Protection Service is satisfied that it contains a concentration of PCBs less than 50 ppm. These labels are available from the regional offices of the Environmental Protection Service (see Appendix).

Waste PCB liquids in drums and discarded equipment should also be labelled with a Number 4 - Severe Hazard Label (see Figure 4). This label is also available from the Environmental Protection Service and should be filled out as in Figure 4.

The code numbers indicate the potential severity of PCB contamination. For example, PCBs are a health hazard (3) because of their effect on the food chain; they will not burn easily (1); they are of great hazard to the environment (4) and they do not readily react with other chemicals or materials (1).



HEALTH SANTE	3	FIRE INCENDIE	1	ENVIRONMENT ENVIRONNEMENT	4	REACTIVITY REACTIVITE	1

CONTENT - CONTENU
This equipment, barrel, drum, package, etc., contains PCBs

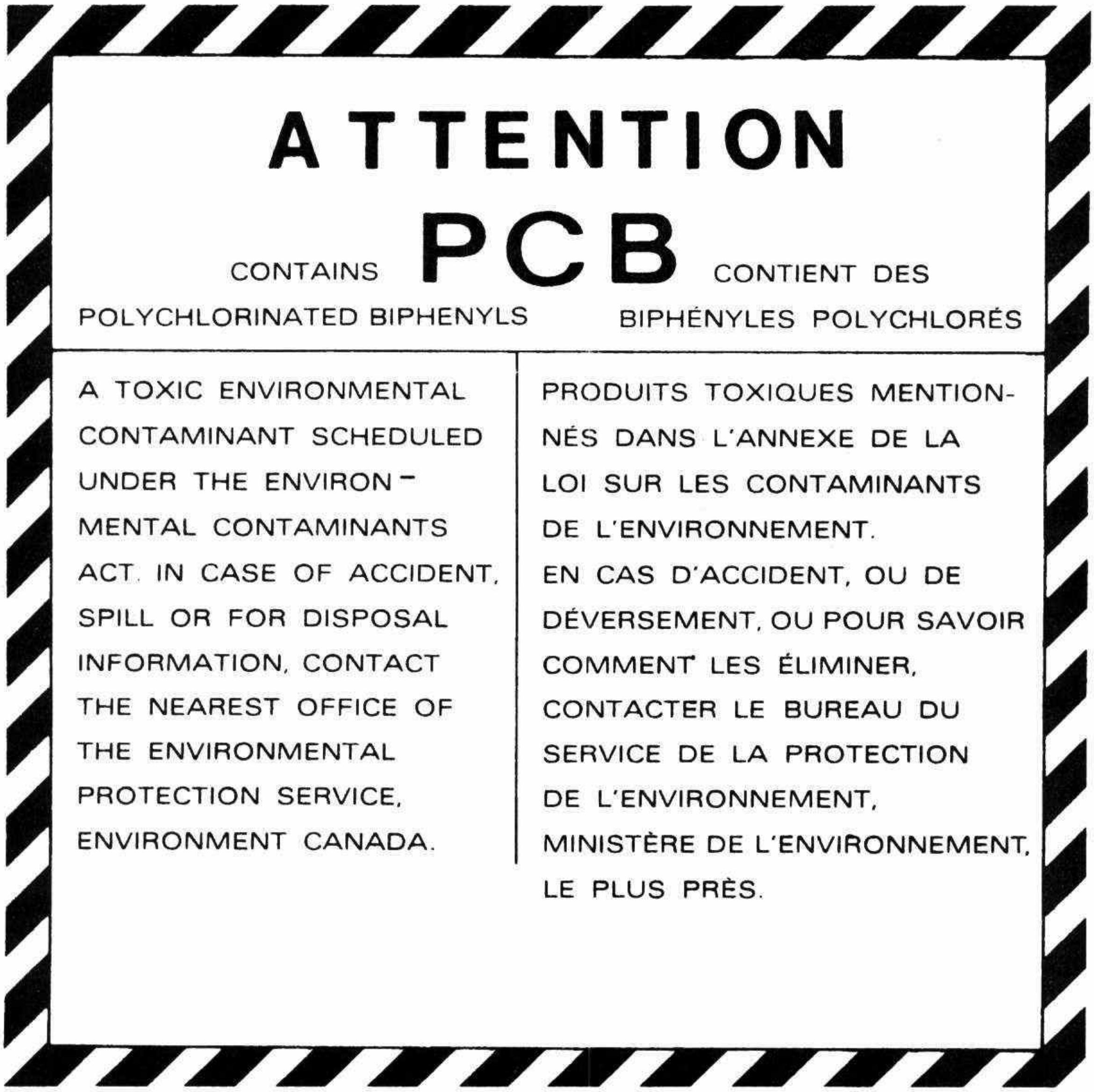
DISPOSAL - ELIMINATION
HANDLING - MANIPULATION Class 9
ORIGINATOR - EXPÉDITEUR
(your company name)
TEL:
TEL: (your tel. #)
DATE: (the date)

Environment Canada Environnement Canada

04-1914 (05/79) 7690-21-872-3175

FIGURE 4 LABEL FOR USE ON PCB WASTES AND DISCARDED EQUIPMENT

Entrances to fenced areas, electrical rooms and transformer vaults should be posted with the non-serialized version of the black and white PCB label (see Figure 5).



ATTENTION

CONTAINS **PCB** CONTIENT DES

POLYCHLORINATED BIPHENYLS BIPHÉNYLES POLYCHLORÉS

A TOXIC ENVIRONMENTAL CONTAMINANT SCHEDULED UNDER THE ENVIRONMENTAL CONTAMINANTS ACT. IN CASE OF ACCIDENT, SPILL OR FOR DISPOSAL INFORMATION, CONTACT THE NEAREST OFFICE OF THE ENVIRONMENTAL PROTECTION SERVICE, ENVIRONMENT CANADA.

PRODUITS TOXIQUES MENTIONNÉS DANS L'ANNEXE DE LA LOI SUR LES CONTAMINANTS DE L'ENVIRONNEMENT. EN CAS D'ACCIDENT, OU DE DÉVERSEMENT, OU POUR SAVOIR COMMENT LES ÉLIMINER, CONTACTER LE BUREAU DU SERVICE DE LA PROTECTION DE L'ENVIRONNEMENT, MINISTÈRE DE L'ENVIRONNEMENT, LE PLUS PRÈS.

FIGURE 5 LABEL FOR USE ON ELECTRICAL ROOMS, TRANSFORMER VAULTS, CHAIN LINKED AREAS AND STORAGE COMPOUNDS

3 PREVENTIVE MAINTENANCE FOR PCB EQUIPMENT

Most askarel transformers should last 30 years; however, power handling capability, operating temperature and amount of physical abuse that a transformer receives will determine its lifetime. Preventive maintenance to preclude operational and environmental hazards is of the utmost importance. The rebuilding of a transformer is not recommended.

3.1 Transformers

The primary purpose of a transformer is to convert electrical power from one operating voltage to another. Immersion of a transformer core in a tank of askarel allows for a good electrical insulating factor between the coil windings (see Figure 6).

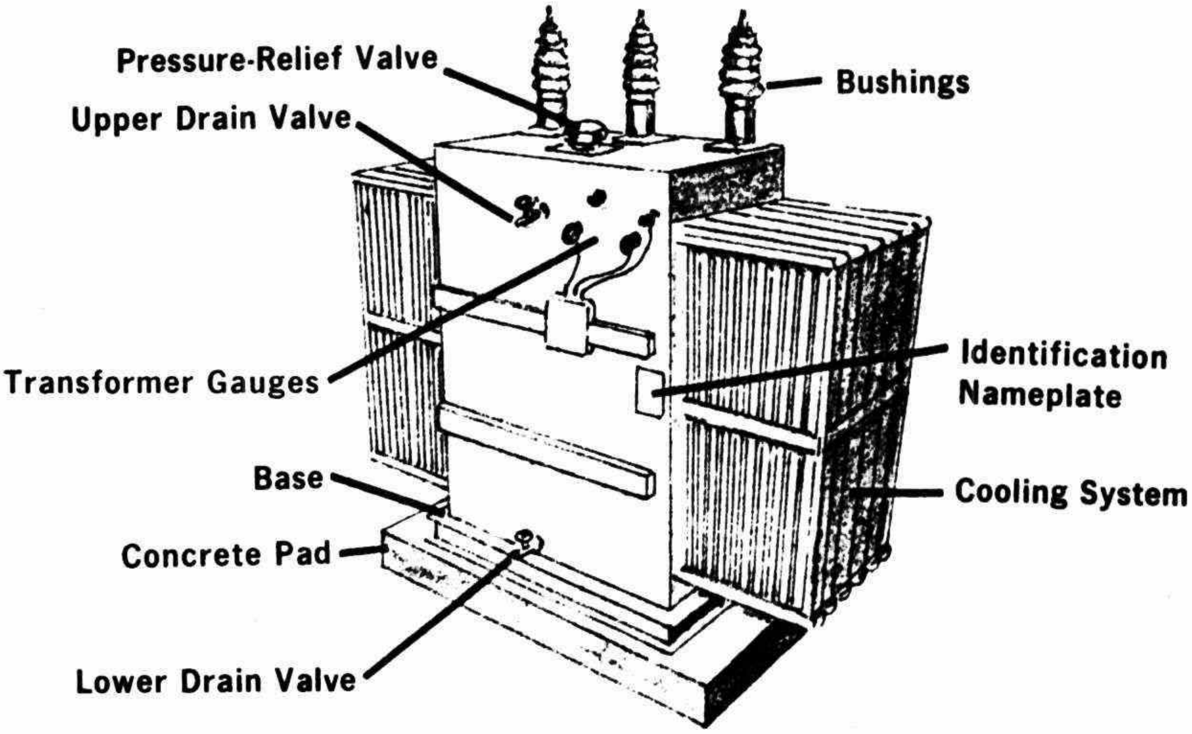


FIGURE 6 A TYPICAL TRANSFORMER

Sparks inside the transformer occur as a result of lightning, switching surges and transient fault conditions on the power line. They normally last only a fraction of a second and the current flow is so small that the disturbance often goes undetected by the protective relays on the power system.

High voltage sparks between conductors produce heat and decompose the askarel in the vicinity of the spark. As a result of askarel decomposition, hydrogen chloride gas, carbon dioxide, askarel vapour, and other hydrocarbon gases as well as carbon particles are produced (see Figure 7) (Stothert Eng. Ltd., 1979). This causes an increase in pressure within the tank, but the gases slowly condense and allow the pressure to normalize. Gauges located on the side of the transformer provide the information necessary to detect problems that may arise within the transformer.

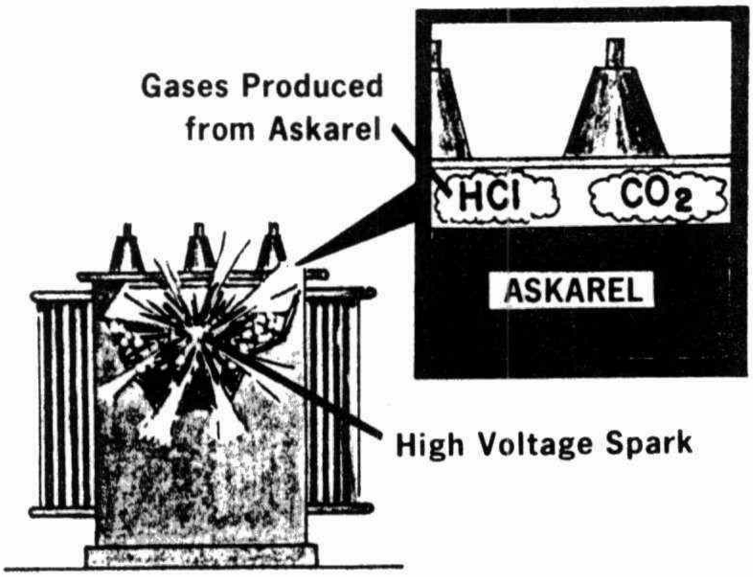


FIGURE 7 DECOMPOSITION OF ASKAREL FROM HIGH VOLTAGE SPARKS

Temperature Gauge

The temperature gauge on a transformer indicates the temperature of the askarel liquid within the transformer (see Figure 8a). Small changes in temperature are expected but normally the temperature should remain much less than 105°C. Excessive temperatures indicate that the transformer is overheating, possibly due to loss of askarel.

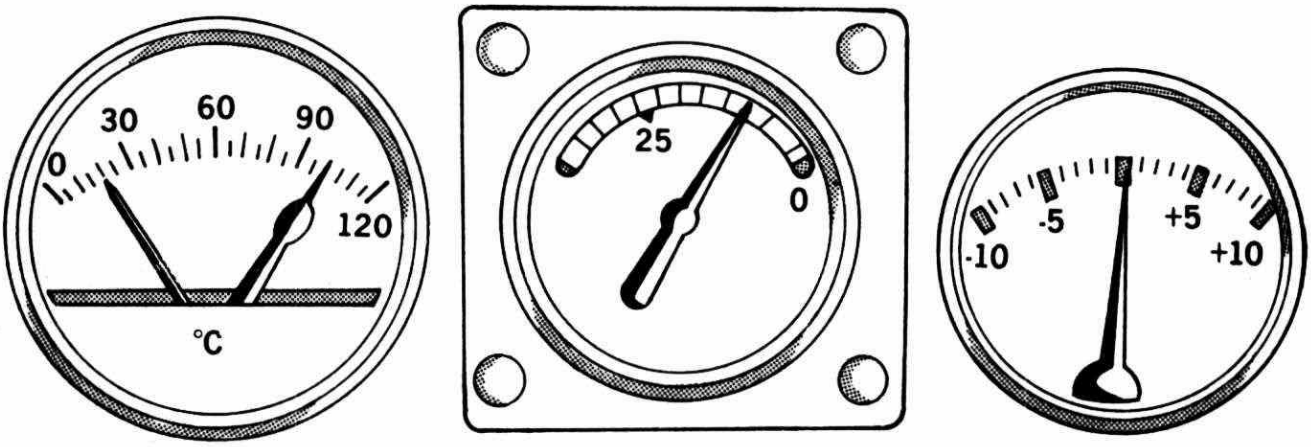
Action should be taken immediately, as the rate of deterioration of insulating materials in the transformer can double for every 8°C rise over normal operating temperature.

Liquid Level Gauge

The level of askarel within the transformer tank is indicated by the liquid level gauge (see Figure 8b). Generally there is a 5 cm air space between the askarel and the tank lid which allows for expansion of askarel liquid due to increased temperature resulting from changes in the electrical load. Gauge readings will change according to temperature and electrical load factors. The minimum acceptable level should be marked on the gauge. A non-PCB fluid must be used for topping up.

Pressure-Vacuum Gauge

The pressure-vacuum gauge measures the vacuum or the buildup in pressure in the space between the askarel and the tank lid (see Figure 8c). As the askarel expands, the pressure in this space is increased. If the gauge pointer does not move, an air leak in the transformer is a possible cause.



a) Temperature Gauge

b) Liquid Level Gauge

c) Vacuum/Pressure Gauge

FIGURE 8 GAUGES FOR A TRANSFORMER

Abnormally high pressure indicates the possibility of internal short circuits and arcing. The pressure-relief valve should release this pressure before it strains or ruptures the tank. The maximum acceptable reading should be marked on the gauge (usually about 70 kPa (10 psi)); if not, check with the manufacturer.

An abnormally high vacuum reading indicates low askarel level; transformer burnout will occur if the level of the askarel drops below the top part of the transformer windings. Also air, moisture and dirt can be drawn into the transformer tank through weak gaskets. The maximum acceptable vacuum reading should be marked on the gauge; if not, check with the manufacturer.

Pressure-Relief Valve

The pressure-relief valve is calibrated to release at abnormally high internal pressure. It is automatic, self-resetting, and self-resealing. The valve is fitted with a visible sign to indicate when it is open.

3.1.1 Transformer Maintenance. A number of problems can develop with transformers; however, through preventive maintenance these problems may be alleviated (see Table 2).

3.1.1.1 Sizing and location. A transformer should be located in an area where it is adequately protected from possible external damaging forces, such as road traffic, caustic environments, or excessive heat.

It is most important to have an electrician check whether the transformer is operating at or near the power level rated on its nameplate. If it is, the addition of another transformer to reduce the load should be considered.

3.1.1.2 Installation of alarm circuits. Gauges should be installed which are fitted with mechanical contacts, that may be connected to alarm systems or to circuit controls that de-energize the transformer automatically in case of abnormal situations (see Table 3).

3.1.1.3 Routine inspections. Transformers must be checked routinely for leaks, overheating and other problems which may arise (see Table 4).

3.1.1.4 Professional services. Professional services may be required to remove an askarel sample for quality analysis or to provide treatment for removal of contaminants or moisture from the tank. Steps that should be followed by a professional when taking an askarel sample for laboratory analysis are:

1) take sample when humidity is <75% and transformer is warm;
2) clean sampling valve at top of transformer;
3) let about 1 to 2 litres of askarel run into a metal catch bucket to flush dirt in spout;
4) collect sample in a 2 litre sample bottle with a Bakelite screw cap after rinsing the bottle 2 or 3 times with askarel from the transformer;

TABLE 2 TYPICAL PROBLEMS WITH TRANSFORMERS

PROBLEM	WHAT CAN HAPPEN
• gradual contamination of the transformer liquid by moisture, dirt, carbon or chemicals resulting from arcing inside the transformer	→ insulating quality of askarel liquid weakens → high voltage sparks occur inside the transformer, causing a buildup of internal pressure → excess pressure forces askarel out of the transformer through the pressure-relief valve or through weakened gaskets → possible environmental contamination
• weakening of transformer seals and gaskets due to aging	→ leaks develop → transformer overheats or burns out from askarel loss → electrical arcs occur inside the transformer since it is no longer properly insulated → catastrophic failure may result
• physical damage or rusting of the cooling radiators • structural damage to transformer tank	→ leaks develop → transformer overheats or burns out from askarel loss → electrical arcs occur inside the transformer since it is no longer properly insulated
• over-heating due to the transformer being undersized for its application (overloading), or because of loss of askarel	→ insulation on electrical windings and insulation materials will deteriorate, allowing short circuits and internal sparks to occur between windings → decrease in life expectancy and possible loss of askarel to the environment
• lightning and other power surges	→ high voltage sparks produced inside transformer, causing a buildup of internal pressure → excess pressure forces askarel out through pressure-relief value or through weak gaskets

Note: It is important to realize that simple inspections should prevent these problems from becoming serious because most involve a gradual rather than a sudden change in operating condition.

TABLE 3 TYPES OF ALARM CIRCUITS TO CONSIDER

TYPE OF GAUGE		REACTION
Dial Type Liquid Thermometer Alarm	→	contacts close when temperature rises above a set limit
Liquid Level Gauge Alarm	→	contacts close when askarel drops below set limit
Pressure-Vacuum Gauge Alarm	→	contacts closed under normal conditions
Pressure-Relief Valve	→	contacts close every time valve operates
Sudden Pressure Relay	→	contacts close whenever there is an abnormally rapid increase in internal pressure which would not cause the pressure-relief contacts to close
Winding Temperature Indicator	→	several sets of contacts close at preset temperature increases

5) cap bottle tightly with aluminum or tin capliner to keep moisture and dust out;
6) label bottle "ASKAREL";
7) top off transformer with tri/tetrachlorobenzene (TTCB) or some other suitable non-PCB makeup fluid to replenish the lost liquid; and
8) dispose of PCB liquids properly after each test.

Consult a regional office of the Environmental Protection Service to assist in this disposal process (see Section 4).

3.2 Capacitors

An askarel capacitor is a hermetically sealed unit with a lifetime of about 10 to 20 years (see Figure 9). There is no provision for internal maintenance because it is sealed. Most capacitors are equipped with fusing to "de-energize" the capacitor in the event of a breakdown (see Figure 10). This prevents the capacitor from bursting open.

Some types of capacitors are constructed with a number of individually fused cells, where the defective capacitor can be removed from the circuit when its fuse melts.

TABLE 4 ROUTINE INSPECTION FOR TRANSFORMERS

INSPECT	WHAT TO LOOK FOR
Condition of gauges	→ cracked faceplates, or damaged gauges (install a plexiglass sheet over gauges for protection)
Reading of gauges	→ change in readings since last tour? → are readings acceptable?
Corrosion on tank and radiator fins	→ check fins very carefully, they are manufactured of thin gauge steel to obtain maximum cooling and will rust through more quickly than the rest of the transformer, especially in a caustic environment (clean to bare metal and paint if rusted)
Paint finish of tank and radiator fins	→ is paint weathering? (repaint as often as necessary)
Leakage or weep of askarel from: - tank - radiator fins - top cover (if gasketed) - manhole cover - top or bottom drain spout - high and low voltage bushings	→ wet slickness and gummy residue → are gaskets or seals deteriorating? Important - if there has been leakage, take steps to clean it up promptly.
Pressure-relief valve	→ are the gaskets displaced so the valve is not seated properly?
High and low voltage bushings	→ are they cracked or chipped? (low voltage bushings are larger, therefore, more likely to leak first)
Colour of askarel	→ take a small sample → is the colour changing from clear to a blue, green, red or blackish cast? If so, it is becoming contaminated. (consider a laboratory test to check its quality)

Note:
- one person should be appointed for transformer inspections, done once every 6 months
- use a separate sheet for each transformer to record observations.

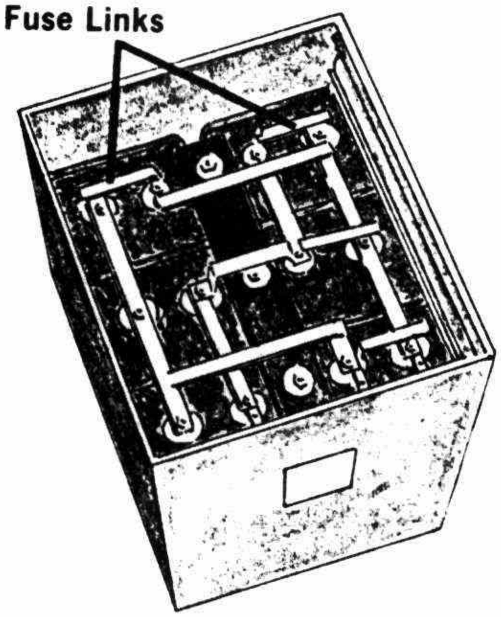


FIGURE 9 A TYPICAL CAPACITOR

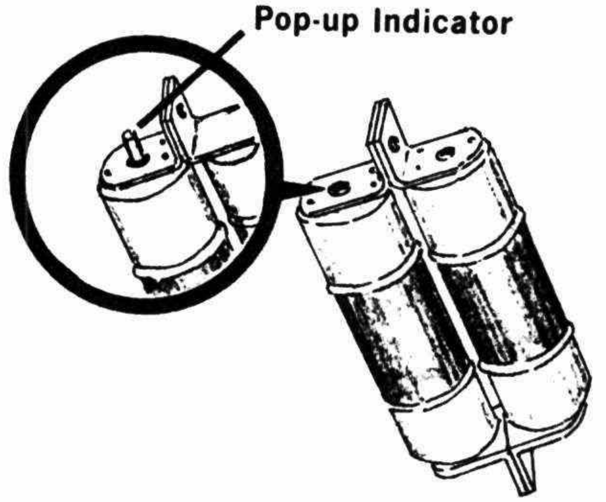


FIGURE 10 INDICATING FUSE ON CAPACITORS WITH EXTERNAL FUSES

This still allows for a certain amount of capacitance. The typical problems associated with capacitors are shown in Table 5.

3.2.1 Capacitor Maintenance. Preventive maintenance for capacitors will help lower the risk of environmental contamination; the location of a capacitor is very important in this respect. The casing temperature should not exceed 55°C under normal operating conditions.

To avoid risk, the following should be considered:

1) proximity to sources of heat;
2) adequacy of ventilation (ambient air temperature should be less than 40°C);
3) adequacy of protection from damage by outside sources; and,
4) operating voltage; if it is 10% or more above the capacitor's rated voltage, corrective action should be taken.

Routine inspections of capacitors should be carried out, as detailed in Table 6.

TABLE 5 TYPICAL PROBLEMS WITH CAPACITORS

PROBLEM	WHAT CAN HAPPEN
rusting of casing; damage to insulator bushings	→ leaks develop → capacitor overheats and internal insulation fails; with askarel loss internal short-circuits develop, causing a buildup of pressure inside casing → rupture of casing may result in contamination of the environment
physical damage to capacitor casing	→ internal insulation may be damaged → internal short-circuits can develop causing a buildup of pressure inside casing
over-heating of capacitor due to loss of askarel or proximity to sources of heat	→ internal insulation deteriorates → internal short-circuits can develop causing a buildup of pressure inside casing
end of lifetime	→ internal insulation fails → capacitor draws large amounts of current and pressure is built up inside casing

TABLE 6 ROUTINE CAPACITOR INSPECTION

INSPECT	WHAT TO LOOK FOR
corrosion on casing	→ rusting is more likely to occur in a caustic environment
physical damage	→ dents, broken insulator bushings
leakage or weep of askarel	→ wet slickness and gummy residue Important - if there is leakage, dispose of capacitor in approved location
melted fuses	→ some capacitors with external fuses have a visual indicator to signal that the fuse has melted (see Figure 10); conduct a continuity test on the capacitor; if defective, dispose of the capacitor in approved location; alternatively, replace the fuse and if it melts again, dispose of the capacitor (see Section 4 for disposal instructions)
temperature of the capacitor casing	→ casing should be warm to the touch, if cold, check fuse → if hot, check for cause of the excessive temperature

Note:

- one person should be appointed for capacitor inspections, to be done once every 6 months
- all disposal activity should only be carried out with the approval of the appropriate environmental authority (see Section 4, for recommended procedures).

4 HANDLING OF PCB LIQUIDS, EQUIPMENT AND MATERIALS FOR MAINTENANCE AND DISPOSAL

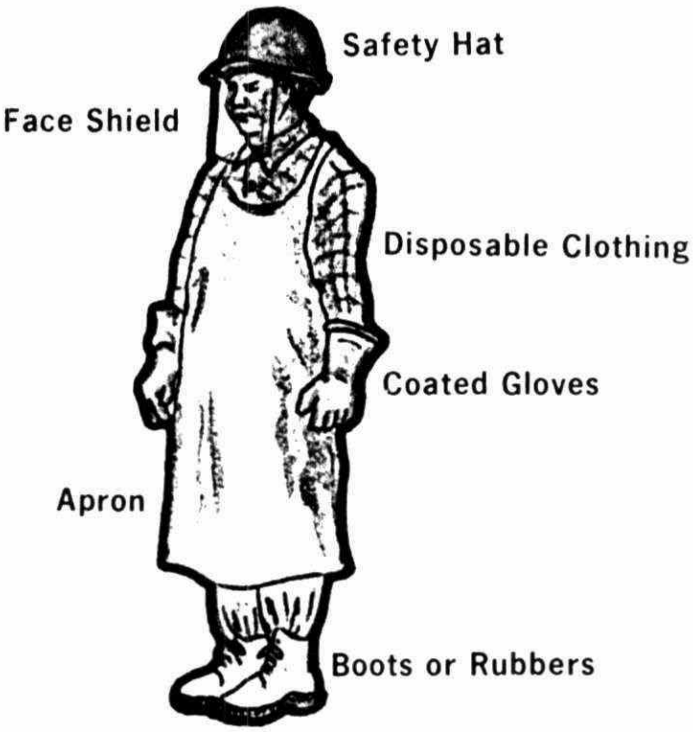
PCB liquids can be completely destroyed at temperatures above 1000°C; however, at present, approved sites for such special incineration do not exist in Canada.

The Environmental Protection Service recommends that PCB liquids be stored until government approved landfill sites or special incineration plants are available.

Individuals who allow PCB liquids to be discharged into water courses can be prosecuted for PCB release under the federal Fisheries Act.

4.1 Safe Handling and First Aid

Routine precautions must be observed while handling PCB liquids. Proper clothing must be worn to protect against the hazards of splashes and spill. This includes:



- face shield or chemical goggles, mono (tight fitting);
- gloves, splash aprons and boots made of PCB-resistant material; and
- a safety hat.

Note: protective clothing should be properly disposed of after handling PCB liquids, as some materials deteriorate after exposure and lose their protective efficiency (e.g. neoprene and rubber).

Additional ventilation is required when working with PCB liquids hotter than 55°C; fumes at this temperature can be irriating to the lungs and eyes. The recommended unloading, handling and pumping temperatures for commonly used types of PCB liquids are listed in Table 7.

TABLE 7 RECOMMENDED HANDLING TEMPERATURES FOR PCB LIQUIDS

PCB-LIQUID PRODUCT	HANDLING TEMPERATURES (°C)
Pyranol A13B3B-3	20 - 55
Inerteen 70-30	20 - 55
Inerteen 100-42	35 - 75

If exposure to hot PCB liquids (>55°C) is necessary, a self-contained breathing apparatus should be worn. Castor oil applied to the skin helps to provide a barrier against the irritation of fumes from PCB liquids. See Table 8 for First Aid treatment.

TABLE 8 FIRST AID FOR CONTACT WITH PCB LIQUIDS

IN CASE OF	FIRST ACTION	SECOND ACTION
• PCB liquids on skin	→ wash with soap and water for at least 15 minutes	→ apply cold cream to reduce feeling of irritation
• PCB liquids in eyes	→ flush eyes with gentle stream of lukewarm water for 15 minutes keeping eyelids apart	→ add a drop or two of opthalmic anesthetic solution, or orthalmic cortisone acetate solution to reduce irritation → see physician
• PCB liquids swallowed	→ press down at back of tongue to induce vomiting → do not give victim anything to drink	→ write down details about the liquid and take victim to hospital emergency or physician immediately
• strong PCB fumes	→ get victim into fresh air	→ if discomfort does not clear up, take victim to physician

Forced air ventilation should be provided in the working area and air exhausted to the outside.

Other precautions are necessary when dealing with PCB liquids. One should:

- pump, not pour, PCB liquids into containers, (this minimizes splash and spillage);
- inspect equipment used to handle PCB liquids frequently and replace if necessary;
- not use PCB-contaminated pumps and hoses for other purposes;
- not use gear-type or other positive displacement pumps; centrifugal pumps recommended for handling hot oil may be used for PCB liquids. All wetted surfaces of the pump should be made of stainless steel. The shaft seal should be an external carbon ring type to eliminate exposure of the packing material to the deteriorating effects of PCB liquids. Valves should be brass or stainless steel lined. Hoses should be flexible metal or lined with tetrafluoroethylene or silicone polymers to protect against deterioration.

4.2 Collection of PCB Liquids and Containment for Disposal

Care must be taken during the collection of PCB liquids that they are not spilled on the ground or down drains. Containers which will house the liquids collected should be clearly marked (PCBs), whether they are full or empty. PCB liquids which have been collected in drip pans under transformers, should be transferred to storage drums as soon as possible to reduce contamination risk. PCB liquids should be moved from one location to another ONLY in sealed metal containers which should not be used for any other liquid; other liquids should not be mixed with the PCB liquids. If a spill occurs, the PCB liquids should be cleaned up immediately as described in Section 6. Caution must be taken when moving PCB items to prevent contamination along the route.

Scrapping Capacitors

Capacitors should be left in their cases unopened, wrapped in a heavy plastic bag and placed into a double bung 45-gallon, No 16 - gauge drum which is fitted with a removable steel lid and a gasket made of PCB-resistant material (see Figure 11). The capacitor should be stored with the terminals up to prevent leakage from the capacitor bushings. The drum should be packed with sawdust or other absorbent material so that any leaks will be absorbed. The drum should then be sealed, labelled and moved to the storage area. Larger capacitors which do not fit in drums should be packaged in heavy gauge plastic bags and these should be heat sealed. The packaged capacitors should then be crated for shipment to the storage area.

PCB liquids are contained in a similar manner, but a 7 to 10 cm air space should be left to allow for liquid expansion.

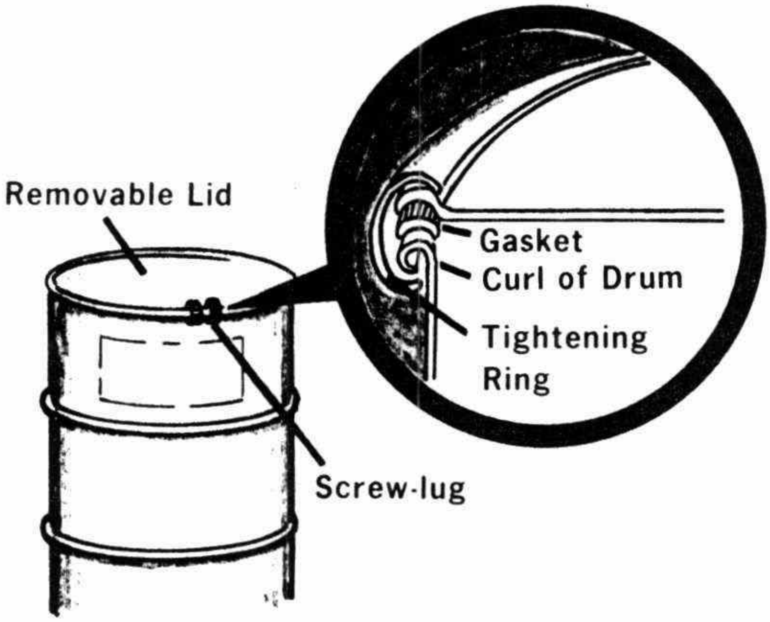


FIGURE 11 CONTAINMENT DRUM

Solid wastes should be wrapped in heavy duty plastic bags, tied shut and placed in the drum, packed with sawdust or other absorbent material, sealed, labelled and transported to the approved storage area.

Scrapping Transformers

Contents of an out-of-service transformer should be pumped into good quality, double-bung, 45 gallon steel drums of No. 16 gauge or heavier. It is necessary to rinse the transformer with solvents such as trichlorobenzene, kersoene or fuel oil at least three times, prior to which the transformer should be placed where any spilled materials may be safely contained (see Section 6). For each rinse, the transformer filled with solvent must sit for at least 18 hours or more to allow the solvent to penetrate the core. The PCB-contaminated solvent should then be pumped into containers for storage, and a protective crate should be built around the transformer prior to transport to the approved storage area. Drain spouts and cooling tubes must be adequately protected, to prevent damage and possible PCB-liquid release during transport. Routine precautions should also be observed during transport to the storage area.

5 STORAGE OF PCB LIQUIDS, EQUIPMENT AND MATERIALS

When PCB articles or equipment are placed in storage, it is necessary that periodic inspection take place to reduce the danger of environmental contamination.

Articles which require storage take a number of forms, and are listed in Table 9.

TABLE 9 PCB ARTICLES PLACED IN STORAGE

New Articles	- spare PCB-liquid capacitors - spare transformers filled with PCB liquids
Discarded Articles	- used capacitors - scrapped transformers - scrapped lighting ballasts
PCB-liquid Wastes	- PCB liquids drained from equipment - PCB liquids collected in drip pans
Contaminated Materials	- earth, asphalt, snow, gravel, etc., contaminated by PCB liquids - absorbent material used to clean-up leaks and spills of PCB liquids
Clothing	- clothing worn when working with PCB liquids
Handling Equipment for PCB Liquids	- pumps and hoses used to transfer PCB liquids

Note: Companies or individuals intending to construct commercial collection or storage facilities for PCB wastes, should refer to the "Guideline on Central Collection and Storage Facilities for Waste Materials Containing PCBs" EPS 1-EC-78-8, published by the Environmental Protection Service, Environment Canada.

5.1 Storage Site Selection

An indoor storage site for PCB wastes is preferable to an outdoor one because it eliminates the danger of contaminated runoff. If outdoor storage is absolutely necessary, the Environmental Protection Service or appropriate government agency should be contacted for information concerning the potential for environmental contamination in the selected area. The site should allow for the construction of a permanent dyke around the facility. In order to minimize the supervisory effort required, one large storage area is preferable to several small ones. This storage area should be large enough for future storage needs and allowance should be made for aisles between containers (for inspection purposes). An ideal location would have a noncorrosive atmosphere, good ventilation, normal room temperature of 25°C or cooler, dry surfaces and concrete floors with no drains (see Figure 12).

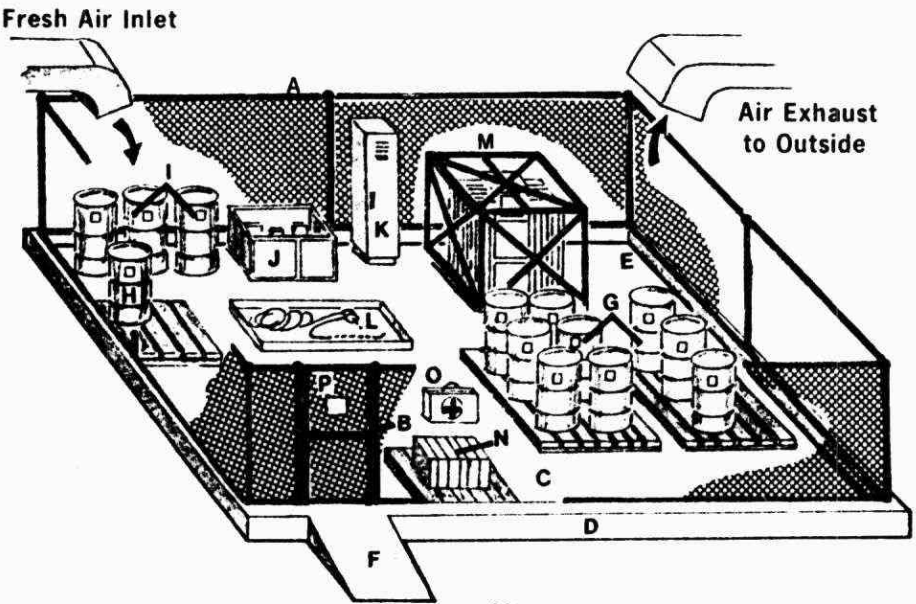
Although an outdoor storage area is not recommended, it is sometimes necessary and it should be located in a safe area (away from road traffic) with provisions made in case of accidental spillage. More care must be taken to prevent corrosion of containers and vandalism in this case (see Figure 13).

5.2 Precautionary Guidelines

Precautions for storage should be taken as follows:

1) appoint a knowledgeable person in charge of the storage area;
2) display the emergency cleanup procedures, post signs indicating storage of PCB liquids and keep doors locked for security;
3) keep First Aid kit handy;
4) store PCB liquids in suitable containers and do not stack them (they may fall);
5) ensure containers are properly painted to prevent rusting;
6) drain and flush scrapped transformers (see Section 4);
7) place metal catch buckets under drain spouts on transformers, and remove handles from valves;
8) install smoke detectors (to warn of fire);
9) seal all cracks and openings in buildings;
10) set up a record-keeping system to keep track of all items entering and exiting the storage area; and
11) maintain an inspection program.

5.2.1 Fire Fighting Safety. If a fire does break out in a storage area, fire fighters should be advised to take special precautions. PCB liquids do not burn easily, but the vapours can be extremely irritating and a self-contained breathing apparatus with protective clothing is required. Foam or dry chemicals should be used to extinguish the fire, rather than water. If water is used, however, minimize the runoff by diking. Protective clothing should be properly disposed of afterwards (see Section 4).



* No open floor drains in vicinity
All floor cracks sealed

A - security fence (chain-link)

B - padlocked door

C - concrete floor, (no drains)
- all cracks and expansion joints between slabs sealed with compound
- floor painted with epoxy paint to prevent PCB liquids from working their way through the concrete; Note: certain paints and compounds deteriorate in PCBs, check with the manufacturer

D - concrete curb around perimeter of storage area; inside of curb painted with epoxy

E - sealing compound (grouting) at corner of curb to prevent leakage under curb

F - ramp over concrete curb, into storage area

G - drums containing used PCB liquids, used capacitors, and contaminated materials
- stored on pallets for mobility

H - drums containing unused PCB liquids stored on pallets

I - spare drums for PCB-liquid materials

J - uncontaminated cleanup materials stored in bin and labelled

K - locker for garments worn when working with PCB liquids

L - pumps and hoses for use with PCB liquids laid in an open pan to catch drips

M - scrapped transformer in protective crate

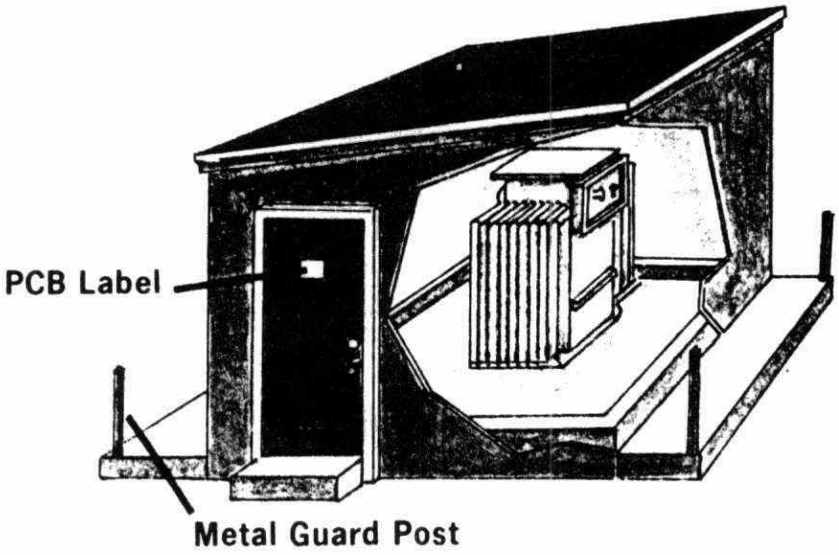
N - spare new capacitors stored on pallets

O - First Aid kit

P - PCB label on door

Q - label with emergency cleanup procedures

FIGURE 12 IDEAL INDOOR STORAGE AREA



a - constructed of fibreglass sheeting
b - transformer mounted on a concrete floor to keep it from shifting
c - concrete curb to contain any leakage
- floor and curb painted with a PCB-liquid and solvent resistant sealer

FIGURE 13 STORAGE AREA FOR A DE-ENERGIZED TRANSFORMER

5.2.2 Record Keeping. Records should be kept of items taken out of or brought into the storage area. Information kept should include:

1) Date - the date goods are removed or received;
2) Description - a description of goods including nameplate description, serial numbers, PCB registration number and quantity;
3) Destination/Source - an indication of where goods are being taken or where they are received from;
4) Storage Code - for outgoing and incoming goods, an identification number indicating where the goods are stored in the storage area; and
5) Authorization and Department - name and department of the person in charge of transfer of goods.

A typical PCB-liquid storage record is shown in Figure 14.

PCB-LIQUID STORAGE RECORD

FOR: DRUMS, [✓ CAPACITORS,] TRANSFORMERS, OTHER

DATE	REMOVED	RETURNED	DESCRIPTION	DESTINATION/ SOURCE	STORAGE CODE	AUTHORIZATION & DEPARTMENT
March 5/79		✓	50 KVAR Capacitor Catalog # 816080DA13 PCB Serial # PR11869 Inerteen	From #1 feed water, sump - Boiler house	Barrel 26	J. Smith Chief Electrician

FIGURE 14 PCB-LIQUID STORAGE RECORD

6 CONTAINMENT SYSTEMS AND CLEANUP PROCEDURES FOR PCBs

6.1 Types of Askarel Release

6.1.1 Transformers. There are a number of ways askarel may be released from a transformer. *Catastrophic failure* occurs only in an energized transformer. It is the rupturing or splitting open of the transformer due to a combination of factors: a buildup of internal pressure caused by a power supply problem; failure of the pressure-relief valve to open quickly enough, and a continued supply of electrical power. Pressure forces an opening through the weakest part of the transformer casing (gaskets or cooling fins). If the opening is above the askarel level, a mixture of hydrogen chloride, askarel vapour and askarel droplets will spray through the opening away from the transformer. If the opening is below the liquid level, a spray of askarel liquid will be forced through the opening. As the pressure is reduced, the askarel will drain out down to the level of the opening.

Controlled pressure release of an energized transformer is the release of pressure through the pressure-relief valve. A momentary burst of hydrogen chloride gas, askarel vapour and droplets spray away from the transformer. Askarel droplets may run down the casing.

Askarel leakage can occur in a transformer that is energized, or one that is in storage. Leakage may occur through deteriorated gaskets; rusted-through cooling fins or casing; broken, high voltage bushings or physically punctured cooling fins and casing.

If the level of the askarel in an energized transformer is too low, a controlled pressure release or catastrophic failure may occur, because the transformer is no longer properly cooled or insulated. These situations may be avoided through routine inspection.

6.1.2 Capacitors. Energized capacitors may experience catastrophic failure from buildup of internal pressure and failure of the power supply to be disconnected in time. The pressure forces an opening through the weakest part of the capacitor.

Leakage may occur in an energized or stored capacitor through a physically damaged or rusted casing. Askarel will drain or drip out to the level of the opening.

6.2 Containment Systems

Containment systems are a method of coping with accidental release of PCB liquids from electrical equipment. Containment should be considered in all situations, but especially for food processing plants, grain handling facilities, city cores and locations close to waterways and drainage facilities.

A variety of materials may be used for containing spills of PCB liquids. Materials that are compatible and those that are not, are listed in Table 10.

TABLE 10 COMPATIBILITY OF MATERIALS WITH PCB LIQUIDS

COMPATIBLE	NOT COMPATIBLE
• wood, paper, paperboard	• organic materials other than wood and paper - e.g. varnishes, lacquers, common paints
• asbestos, glass, ceramic, bakelite, sand	
• aluminum, brass, stainless steel lead, tin, copper, galvanized iron, black iron	• natural rubber, neoprene rubber, butyl rubber
• cork, nitrile rubber, cork-nitrile material (limited time)	• acrylic resin (polymethacrylate)
• Viton material (by DuPont), Teflon, Silastic 50 (by Dow Corning)	• chlorosulphonated polyethylene
• some silicone elastomer materials	• PVC (polyvinyl chloride)
• Glyptal 1276 cement (by General Electric)	• polyvinyl formol
• Epoxy cement	
• dewaxed orange shellac	
• paints with an epoxy-urethane resin	
• some grouting compounds	

6.2.1 Design Principles. Containment systems are designed to minimize the risk of contamination from release of PCB liquids from electrical equipment. Certain design principles should be considered when constructing containment facilities. The sides of the containment facility should allow adequate ventilation, to prevent the transformer from overheating. Construction of a splash wall around capacitors should allow any spray from the capacitors to drip into a containment system below. The entire room in which a transformer is housed may be used for containment, provided the floor is concrete, all cracks and drains are sealed, and there is a surrounding curb. The containment system should be constructed of metal or concrete and sized to contain the contents of the transformer (or capacitor).

Metal drip trays should have continuous welding not spot welding and sufficient room should be left for inspections and cleanup operations. If the transformer requires jacking during installation of the drip tray, do so only at approved bearing surfaces on the transformer to prevent damage.

Figure 15 is a three-stage drawing showing a de-energized transformer being raised so that a metal tray can be slid underneath. A forklift truck could also be used for lifting. The entire tray should be painted with a paint resistant to PCB liquids to prevent rusting and make cleanup easier. The final welds should also be painted.

Where several transformers are located in a common area, it is advisable to provide each with a containment system to reduce the area to be cleaned in the event of a spill. Figure 16 shows an outdoor containment facility for transformers, where concrete curbing has been constructed around and between each transformer.

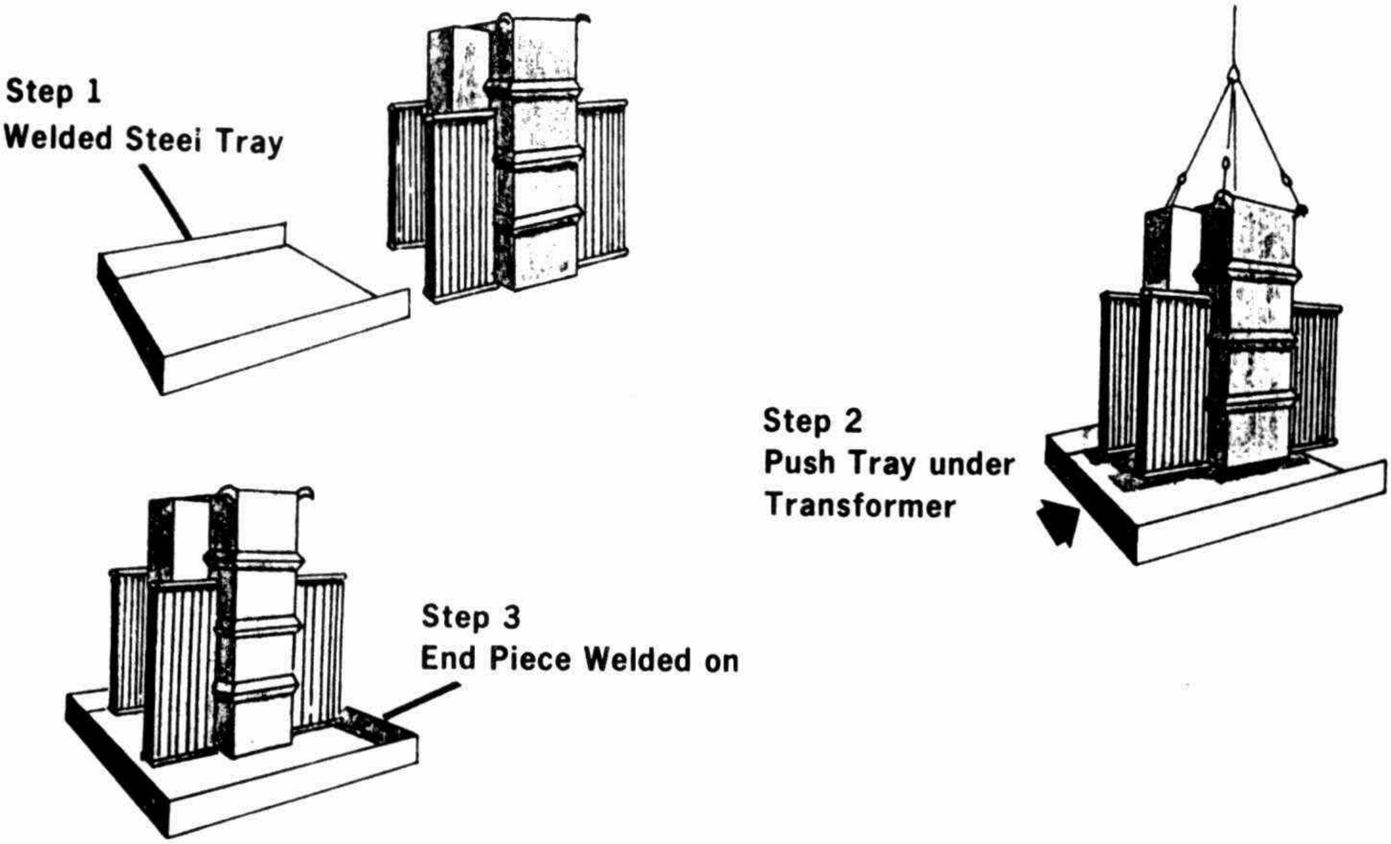
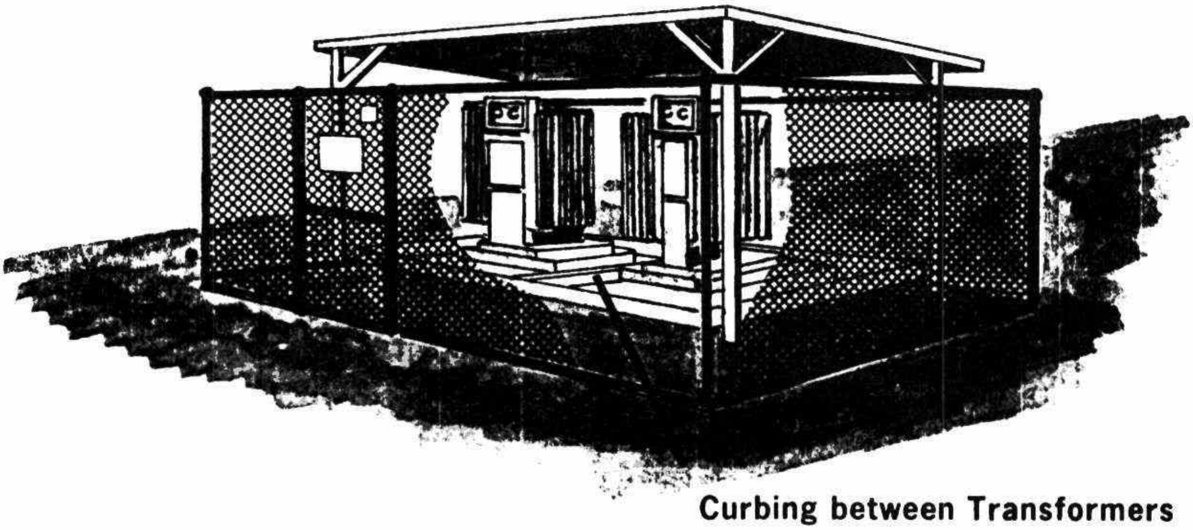


FIGURE 15 TYPICAL CONTAINMENT SYSTEM FOR A TRANSFORMER



Curbing between Transformers

These guidelines are also helpful:

1. - concrete surfaces should be thoroughly cleaned, before plugging cracks or applying any sealing paint (use industrial strength cleaner if necessary)
2. - assure adhesion between new concrete curbing and an old concrete floor by:
   - chipping down the old concrete to a fresh level
   - installing 1.5 cm self-drilling anchor pins on 1 m centres along the perimeter for the new curb; leave 7.5 to 10 cm exposed above the surface of the floor
   - preparing surface with a concrete bonding agent
3. - all cable-entries to a transformer via the floor should be well-sealed at the floor entrance with caulking compound
4. - roof-water drainage should be directed away from the inside of the containment facility to prevent a buildup and possible runoff of contaminated water
5. - drain spouts incorporated into the base of concrete curbing are not recommended for leading off askarel collected inside the containment area; they may leak and will certainly allow spillage onto the ground during the drainage process

FIGURE 16 OUTDOOR CONTAINMENT SYSTEM FOR AN ENERGIZED TRANSFORMER

6.3 Cleanup Procedures

A variety of sorbent materials are available for PCB liquids (see Table 11). Solvents which are suitable for wiping up and decontaminating the surfaces exposed to PCB liquids include: Varsol, kerosene, turpentine, no. 1 fuel oil, and 1,1,1-trichloroethane. Acetone and toluene are not recommended because of their relatively high flammability.

Cleanup procedures vary slightly depending on the location and the severity of the spill. Sequential steps for cleanup are outlined in Table 12. Four different sequences are listed, each depending on the location of the spill.

Cleaning up after a fire involves steps similar to those found in Table 12. Do not initiate cleanup, however, until the temperature is reduced to normal (room temperature).

TABLE 11 SORBENT MATERIALS (this list is not exhaustive)

- sawdust
- vermiculite
- Imbiber Beads (by Dow Chemical, Sarnia)
- Hy-Dry (by Tennier Chemicals, Hamilton)
- Diasorb (by Diamond Shamrock, Cleveland, Ohio)
- Stay-Dry (by Waverly Mineral Products, Philadelphia)
- Oil-Dry (by Waverly Mineral Products, Philadelphia)
- Oil-Sorb (Seneca Paper Products, Oakville, Ontario)
- activated charcoal
- soil with a high humus content

TABLE 12 STEPS FOR CLEANUP OF PCB LIQUIDS

STEPS INVOLVED	LOCATION OF SPILL			
	Leakage into Containment System	Spills on Concrete and Asphalt	Spills on Soil	Spills into Water
• notify plant personnel and the Environmental Protection Service of spill and cleanup intentions	1	1	1	1
• take safety precautions to avoid personal contamination	2	2	2	2
• use pump to transfer PCB liquids into drums	3 (a) see 3(b) if impossible to pump		4 (a) see 4 (b) if impossible to pump	
• plug or dike all drains to sewers and ditches		3		
• build dikes to contain PCB liquids in small area			3	
• dam area if possible, and close off to vessels in navigable waters				3
• take core samples to determine penetration		7 (2.5 cm deep samples)	6 (60 cm deep samples)	
• soak up PCB liquids with sorbents	3(b)	4	4 (b)	
• wipe area with rags and solvents	4	5		
• cover with plastic sheeting to minimize runoff from rain, before excavation		8		
• use dredges to collect contaminated sediment				4
• remove surface area past level of contamination		9	7	
• monitor wells and other bodies of water afterwards for traces of PCB-liquid contamination			8	
• dispose of contaminated materials and waste PCB liquids	5	6	5	5

7 TRANSPORTATION PROCEDURES FOR PCBs

Under the Transportation of Dangerous Goods Code, PCBs are listed under United Nations number UN2315. This is a permanently assigned number which enables containers of PCBs to be recognized internationally.

Before transporting PCBs anywhere, contact must be made with the following:

1) Receiver:

   Check that the receiver will accept the shipment and that appropriate storage facilities are available.

2) Transport Company:

   Ensure that the transport company has the knowledge, ability and proper equipment to move contaminated materials.

3) Provincial Government:

   Contact provincial governments to obtain necessary permits, waybills and placard information, in observance of provincial transportation regulations. These vary with each province.

4) Federal Transportation Department:

   For interprovincial or international shipments, contact the Federal Government for information on shipment and necessary requirements.

5) Environmental Protection Service:

   For interprovincial or international shipments, contact the Environmental Protection Service emergency offices in each province along the route ten working days in advance. The emergency offices should be provided with information concerning: date of shipment; route; name and quantity of PCBs; carrier company; name of driver; vehicle identification and vehicle licence numbers (see appendix for telephone numbers).

Any changes in information should be brought to the attention of the nearest emergency office, which will notify the others en route. The Environmental Protection Service requires that the driver notifies the nearest emergency office in the event of a delay, accident or spillage causing PCB contamination.

7.1 Packaging and Transport Methods

To avoid environmental contamination, drums containing PCB-contaminated materials should be packaged carefully as follows:

- remove any spouts fitted to drums and replace with leak-proof bungs;
- no drums of PCB liquids or materials should be transported unless they are free from mechanical defects;
- drums should be strapped vertically to pallets and horizontally to each other and braced to prevent movement during transport; the end, sides or doors of the truck should not be relied upon to prevent shifting of the containers;
- the load should be arranged to take into account the floor strength and the centre of gravity;
- solid materials which are transported on the same vehicle should be braced to prevent puncturing the containers; and
- transformers should be wrapped in plastic and secured to pallets before being transported.

When transporting the drums, care should be taken that there is no rough handling of containers. Each container should be labelled and a placard should be placed on the vehicle if the weight of PCBs including their packaging and small containers is greater than 500 kg, as required by the "Transport of Dangerous Goods Act". At the destination, the containers should be checked to ensure that no leakage has occurred. A vehicle which has a load containing PCBs and is not placarded may be moved **only** in an emergency situation; or, if the driver is accompanied by a Federal, Provincial, or Municipal Government representative; or, if the driver has the permission of the Ministry of Transport.

The driver should be informed of:

- the nature of the load;
- the location of emergency equipment and its use;
- the reporting procedures to be followed in the event of an accident or incident;
- the need to replace placards and labels if lost or damaged in transit (keep a supply on the vehicle); and
- the requirements to notify the receiver of goods immediately that PCBs are being transported.

A person familiar with PCB liquids should always be present during on-loading and off-loading. Containers should not be moved until vehicle is immobilized. As well, any vehicle which shows signs of leakage from containers should be decontaminated after unloading (see Section 6 for cleanup procedures).

Precautionary measures should be taken during containment, storage and shipping of PCB liquids. Cleanup materials should be transported in the vehicle in the event of a spill. Also empty containers could aid in cleanup operations. Metal-lined truck boxes are preferable to flat bed trailers or wooden truck boxes. The bed of the truck can be lined with plastic sheeting for added protection, or provided with internal curbing to contain leaks. In case of a leak, the vehicle should be stopped, the Environmental Protection Service notified, and cleanup procedures initiated. If the leak can be contained inside the truck box, spread plastic sheeting underneath the truck to prevent leakage from soaking into the ground.

An identification placard 25 x 25 cm in size should be placed at the midpoints of the rear and each side and, where the vehicle is an uncoupled trailer, on the front of the vehicle. Ensure that the placards are visible (see Figure 17).

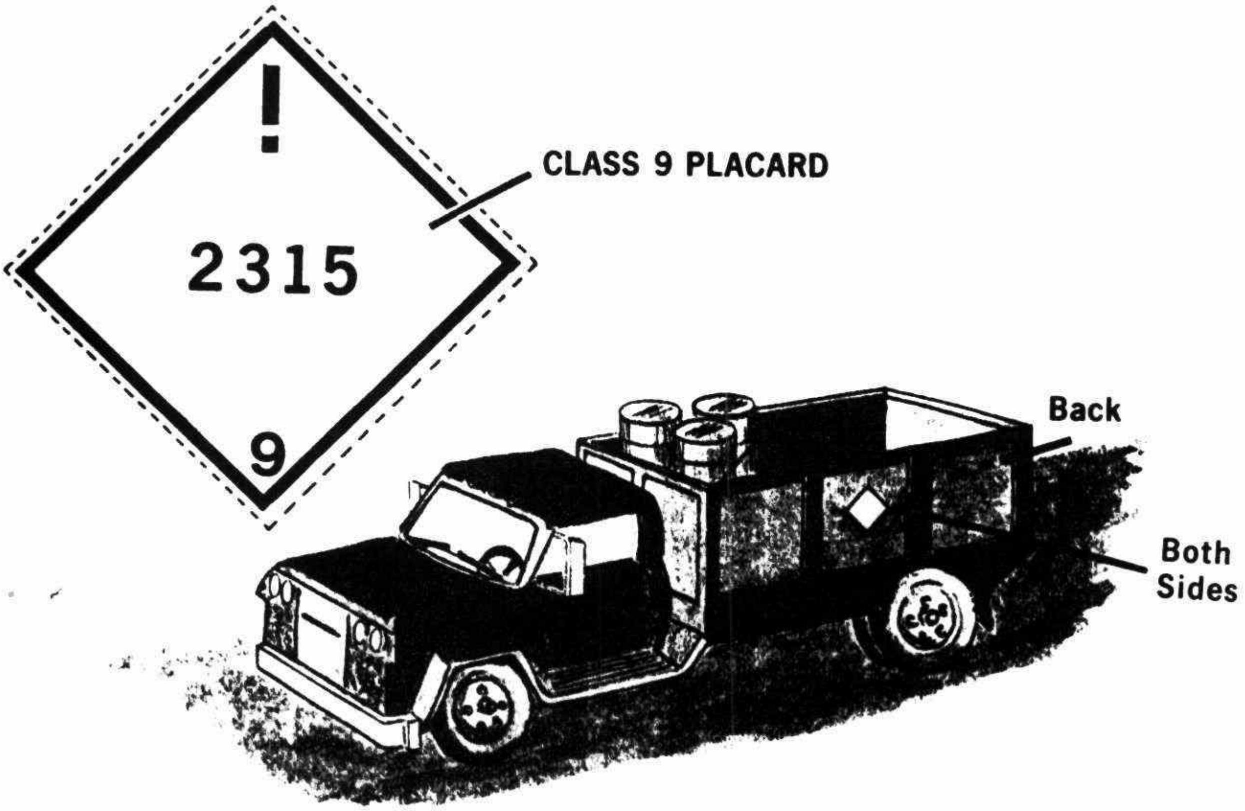


FIGURE 17 PLACARDING ON A TRANSPORT VEHICLE

8 SUBSTITUTE CHEMICALS FOR PCBs USED IN TRANSFORMERS

Sometimes, it is necessary to add liquid to a transformer tank to replenish PCB liquids lost due to leakage or sample testing. Under the regulations of the Environmental Contaminants Act, topping up with PCB liquids is prohibited. A suitable substitute such as tri/tetrachlorobenzene (TTCB) or refined paraffinic oil must be used.

Information concerning the maximum allowable makeup fluid, (usually 20-40% of the tank size) should be available from the manufacturer. Excessive amounts of makeup fluid may alter the transformer performance or soften the insulation on the transformer windings. If a large quantity of makeup fluid needs to be added, it must be added slowly to allow mixing with the PCB liquids.

Retrofilling involves the removal and replacement of askarel in electrical equipment, with other types of liquids. In certain applications retrofilling may be preferred to replacement of a PCB-liquid transformer with a PCB-free transformer.

An ideal alternative to PCB liquids should exhibit a number of desirable properties.

These would include:

- a low degree of degradation while in use over a period of time;
- compatibility with the materials used in the transformer;
- a high fire point for safety;
- a high dielectric strength (>30kV);
- a high resistance to breakdown from internal arcing;
- a low vapour pressure;
- a low thermal coefficient of expansion;
- a low pour point to enable cold startup;
- a low rate of heat release in the event of a fire;
- good thermal conductivity, specific heat and low viscosity over the entire range of operating temperatures;
- specific gravity above or below that of water or ice;
- absence of toxic products in decomposition or combustion;
- non-toxicity and biodegradability in the environment; and
- reasonable cost and adequate supply.

Silicone fluids exhibit some advantageous properties such as: a low pour point, a high fire point, a low rate of heat release upon combustion and fairly low viscosities over the entire range of operating temperatures. Silicone fluids also have some observable disadvantages, which make them not entirely acceptable as an alternative to PCB liquids. Silicone fluids are not compatible with certain gasket materials and winding insulation material found in transformers. The specific gravity of silicone fluid is such that, in cold weather, water will sink to the bottom of the transformer while ice crystals which form are buoyant and will rise to the top. During heat up from a cold start, water (melted ice crystals) could migrate through the fluid and reduce its dielectric strength. Also, PCB liquids are soluble in silicone only up to 8%. The cost of silicone fluid is relatively high.

Chlorinated benzenes, such as tri/tetrachlorobenzene (TTCB), are fluids which can be used as alternatives to PCB liquids. They closely approximate the properties of PCB liquids, are compatible with them, and are generally suitable for use in PCB-liquid transformers. Chlorinated benzenes are currently being studied for their toxicity and environmental effects. These fluids are extremely powerful solvents and often are not compatible with many gasket materials normally used in electrical equipment.

Aliphatic hydrocarbons have a low degree of in-service degradation and are compatible with all materials normally used in construction of electrical equipment. The fluids do not pose serious environmental problems, are biodegradable, easily disposed of and compatible with all other dielectric fluids. The cost of manufacturing is one of the lowest of all PCB-liquid substitutes and raw materials are in good supply. There are disadvantages associated with the use of these fluids, however. Blended additives are required to depress the pour point, and improve thermal and oxidative stabilities. These oils have a high viscosity at low temperatures and a high rate of heat release during combustion. There also exists a higher gassing tendency under electrical stress, than for conventional transformer oils.

Poly-α-olefins (synthetic hydrocarbons) are compatible with materials used in transformer construction, and with other hydrocarbon fluids. They exhibit negative gassing tendencies under electrical stress and have a specific gravity below that of water and ice. Disadvantages of using these fluids are cost, and the high rate of heat release during combustion.

Esters are considered an alternative to PCB liquids because of their low flammability and high performance characterics. A blend of esters of pentaerithritol and fatty acids is offered as a PCB-liquid substitute. The dielectric strength, thermal conductivity and coefficient of expansion are comparable to those offered by typical transformer oils. No toxic substances are generated during arcing conditions. Esters are compatible with most materials used in transformers.

Characteristics of PCB-liquid alternatives are outlined in Table 13.

TABLE 13 PROPERTIES AND COSTS OF PCB-LIQUID ALTERNATIVES

	PCB-LIQUID ALTERNATIVES				
PROPERTIES	Silicone Fluid	Aliphatic Hydrocarbons	Chlorinated Benzenes	Poly-α-olefins	Pentaerithritol Ester Blend
• minimum dielectric strength (kV)	35	35	32	40	50
• thermal conductivity (W/(m•°C) (@ 25°C)	15.1×10^{-2}	13 to 13.4×10^{-2}	6.7×10^{-2}		15.5×10^{-2}
• specific heat (kJ/(kg•°C) (@ 25°C)	1.53	1.93	1.59	2.09	2.1
• viscosity (cm²/s) at					
-40°C	3.0				
-17.8°C	1.50			83.0	
20°C			0.034		1.0
25°C	0.50	3.5	0.025		
50°C		0.85			
100°C	0.16	0.15	0.008	~ 0.13	0.06
150°C	0.1				
• pour point (°C)	-55	-30	-30	-48	-50
• specific gravity at					
15.6°C				0.86	0.98
20°C			1.39		
25°C	0.960	0.877			
• thermal coefficient of expansion (cm³/cm³/°C)	10.4×10^{-4}	7.5 to 8.5×10^{-4}	8×10^{-4}	4×10^{-4}	7.5×10^{-4}
• fire point (°C)	365	310 to 312	none to 210°C (b.p.)	315 to 321	>310
• rate of heat release (kW/m²)					
• convective	53 to 66	538 to 546	370	564	337
• radiant	25 to 26	361 to 441	238	414	116
COST ($/L, Aug. 1982)	7.25	3.59	5.30	3.05	N/A

REFERENCES

M.M. Dillon Ltd., "1982 Review of Substitutes for PCB in Transformers", prepared for the Contaminants Control Branch, Environmental Impact Control Directorate, Environmental Protection Service, Ottawa, (unpublished).

Environmental Protection Service, "Guideline for the Management of Waste Materials Containing Polychlorinated Biphenyls (PCBs)," Environment Canada, EPS 1-EC-78-1, (1978).

Environmental Protection Service, "Guideline on Central Collection and Storage Facilities for Waste Materials Containing Polychlorinated Biphenyls (PCBs)," Environment Canada, EPS 1-EC-78-8, (1978).

Stothert Engineering Ltd., "PCB Handbook for the Management of Electrical Equipment and Wastes Containing Polychlorinated Biphenyls", Environmental Protection Service, Environment Canada, Pacific and Yukon Region, Regional Program Report 79-19, (March 1979).

APPENDIX

ENVIRONMENTAL PROTECTION SERVICE OFFICES

Regional Offices

Region	Address	Telephone
Pacific and Yukon	Environmental Protection Service Kapilano 100 Park Royal West Vancouver, B.C. V7T 1A2	Emergency - (604)666-6100* Office - (604)666-6711
Western and Northern	Environmental Protection Service Room 804 9942 - 108th Street Edmonton, Alberta T5K 2J5	Emergency - (403)420-2580* Office - (403)420-2005
Ontario	Environmental Protection Service 7th Floor 25 St. Clair East Toronto, Ontario M4T 1M2	Emergency - (416)966-5840* Office - (416)966-5840
Quebec	Environmental Protection Service 4th Floor 1550 de Maisonneuve Blvd. West Montreal, Quebec H3G 1N2	Emergency - (514)283-2333* Office - (514)283-2347
Atlantic	Environmental Protection Service 5th Floor, Queen's Square 45 Alderney Drive Dartmouth, N.S. B2Y 2N6	Emergency - Maritimes Zenith 49000* - NFLD (709)737-2083* Office - (902)426-6141

*24 hour service

District Offices

District	Address	Telephone
Newfoundland	Environmental Protection Service P.O. Box 5037, Building 310 Pleasantville St. John's, Newfoundland A1C 5V3	Office - (709)737-5488
Prince Edward Island	Environmental Protection Service P.O. Box 1115 Charlottetown, Prince Edward Island C1A 4A9	Office - (902)892-8551
New Brunswick	Environmental Protection Service Box 600 Fredericton, New Brunswick	Office - (506)452-3286
Ontario	Manager, National Capital Area Environmental Protection Service River Road Ottawa, Ontario K1A OH3	Office - (613)998-8830
Manitoba	Environmental Protection Service 800 Kensington Building 275 Portage Avenue Winnipeg, Manitoba R3B 2B3	Office - (204)949-2961
Saskatchewan	Environmental Protection Service 930 Avord Tower 2002 Victoria Avenue Regina, Saskatchewan S4P OR7	Office - (306)569-6464
Northwest Territories	Environmental Protection Service 9th Floor, Bellanca Building Yellowknife, Northwest Territories XOE 1HO	Office - (403)873-3456
Yukon Territory	Environmental Protection Service Room 225, Federal Building Whitehorse, Yukon Territory Y1A 2B5	Office - (403)667-6487*

*24 hour service

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